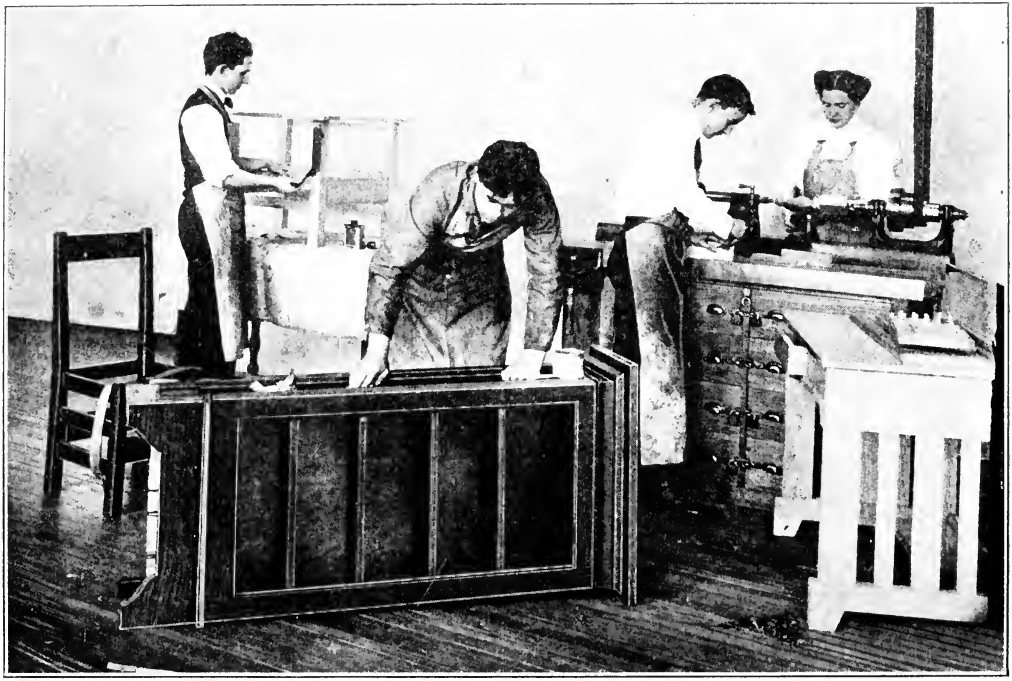
ELEMENTARY CABINETWORK

FRANK HENRY SELDEN



Pupils at work on type-forms of cabinetwork

ELEMENTARY CABINETWORK

FOR MANUAL TRAINING CLASSES

By

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PART III

Description of Essentials for Cabinetwork

THE INTRODUCTION

THE AIM of this work is to make clear, through definite directions for making the articles illustrated, the general principles of furniture construction, so that the pupil may apply them in making other articles from designs found in trade journals and elsewhere. Although this book is the result of a teacher's experience in manual-training schools, yet it will also be helpful for self-instruction in the home shop.

Knowledge of the correct use of ordinary woodworking bench tools must be gained before any attempt is made in the construction of furniture. Such knowledge is imparted in the author's earlier volume, "Elementary Woodwork."

Elementary Cabinetwork is not to be used merely as a reference book at the instructor's desk, but is designed as an aid to study and is to be placed in the hands of each student. The instructor should see that the projects to be made by each pupil are of such a type as will demand a systematic study of the text.

Though designing and cabinetmaking are different subjects, yet the peculiar arrangement of the text, the variety of designs presented, and the suggestions for new forms and combinations will be found to teach, in the most effective way, the elements of furniture designing.

It is assumed that the pupil already has such knowledge of the elements of woodworking and turning as may be gained from the author's preceding works on those subjects. This book aims therefore, to direct the pupil in further study through applying these elements to solving a series of typical problems in practical construction.

For convenience of study the subject-matter of the book has been arranged in three parts: Part I presenting such general directions as seem needful to add to the knowledge which it is assumed the pupil has already acquired; Part II presents a series of tested problems in actual construction found to be within the ability of the pupils of the secondary school; Part III treats of certain special tools and finishing processes not described in elementary study.

Suggestion rather than variety of designs, has been the aim. A few processes thoroughly learned and properly used in typical problems, are far better for educational purposes than attempts at greater variety made at the cost of incorrect practice, and the sacrifice of progressive study to a single exigency in mere construction. No provision is made in this work for the use of wood files and frame saws, because the author firmly believes that their use can easily be dispensed with. Moreover, their habitual misuse has not infrequently impaired the educational value of manual training in a marked degree. For a similar reason the use of the spokeshave has been reduced to a minimum.

The value of the shop work depends upon intellectual activity rather than muscular reaction. Hence problems are selected which encourage thinking and the develop-

ment of definite mental activities rather than problems which, by repetition of their processes, lead to skill or the power to perform certain operations by muscular reaction, the mind, meanwhile, being passive or but indefinitely active.

The work of the pupil will be truly educational only in proportion as he is led to use his mind in each operation. Therefore, not only such problems as will tend to encourage mental rather than physical effort should be used, but the whole attitude of the pupil in his shop work should be one of study rather than one of acquiring skill by mere muscular repetition.

No pupil is expected to construct every article described in the text, but by selecting a typical form from each group, he may readily master all the essential problems of elementary cabinetmaking.

Upholstering is not taken up in this volume because of want of space for satisfactory treatment.

The typical designs given herein may be modified in many ways without lowering their value as studies, and the instructor should aid pupils in devising adaptations of wood, finish, and upholstering, suitable for their special needs; taking special care to keep each design within the proper limits of a study. If there appear to be no controlling factors of this nature, let convenience of material be the guide.

It is recommended, as promising greater educational service, that for school class-work the simpler forms of finishing and upholstery be employed, so that more time may be given to the study of woodworking problems. For this reason board and heavy leather seats have proved best suited for school use.

Although the drawings in this book show exact dimensions, there is usually a very wide range for size-modification in the various parts of the designs offered. The text suggests only a few of these size-modifications; but in adopting any such, care should be exercised to keep the designs suitable for school work and adapted to the progress of the individual student. For example, avoid attempts to construct articles with very small tenons, or parts which may be crowded or sprung into position.

Every part and joint should be of such form and size as will compel an intelligent and definite method of work. If there is carelessness, or indefinite method used, the result must be a failure.

SUGGESTIONS FOR THE PUPIL

It is especially urged that before the pupil attempts the construction of any article described in this book, he read all the general directions. As he proceeds with each piece he should repeat this, reading all of the references given in the text, until he has a clear understanding of all parts of the directions, and is able to recall each part as he has use for it.

The purpose of the general directions is to give the pupil so clear an idea of the methods of combining two or more pieces, as to reduce the number of mistakes and the amount of spoiled material to a minimum. He will, therefore, save time as well as material by studying all of Part I before beginning any project. As he proceeds with the project, or type example selected from Part II, he will find references to various topics in Part I, and these, as well as all other topics that may assist in the work, should be thoroughly studied. If the pupil requires information not found in these topics, he should consult the index in the back of the book. Always proceeding on the supposition that the desired information is to be found in the book, he should continue to refer to the index until practically all information required for making any of the projects is found.

He should not attempt to make any article illustrated until he has learned to plane out of wind and straight. He should also learn to lay out and to make simple joints, and should be certain that they will be of correct shape and properly fitted, before attempting the study of any article containing combinations of joints. It is a waste of time to attempt the construction of any article, however simple, before gaining a knowledge of the more simple problems.

It should be borne in mind, however, that this book does not include directions for planing, use of knife, try-square, and other fundamental studies in woodworking, these topics being treated at length in the preceding volume, "Elementary Woodwork." Hence, before attempting any project in cabinetmaking the pupil should make himself thoroughly familiar with the instructions given in that work. The fundamental knowledge of tool operations acquired through such a systematic study of that text, will not only add much to his interest in cabinetmaking, but will prove a saving of time when he attempts to make any project laid down in "Elementary Cabinetwork."

PART I

General Directions

EQUIPMENT FOR ELEMENTARY CABINETMAKING

The Care and Use of Tools. The first problem in cabinetmaking is to learn how to combine several simple pieces. The shaping and combining of pieces of irregular outline should not be attempted until the elementary principles of combining have been learned.

It is, therefore, a matter of great importance that the equipment for elementary cabinetmaking be restricted to such tools as are required for plain, simple work only. This being the case, scarcely any more tools are needed for the first work than are used in elementary joinery.

The equipment for each pupil and bench should be the same as that required to do the work given in "Elementary Woodwork." Such tools as are described in Part III should be kept in the tool room for general use.

In all work in cabinetmaking, the tools should be kept in the best condition. Test the squares to see that they are correct. Examine the bench top for

any roughness that may injure the work. The jaws of the vise should also be examined and refinished if necessary. Keep each chisel ground to as thin an edge as is consistent with rapid use. Be especially careful that the side which ought to be straight is straight to the very edge. The saws should cut freely but not roughly, as a rough end requires too much planing or chiseling.

The pupils at work and the daily results of their work have furnished the material for the illustrations. No attempt has been made to produce a picture book of furniture designs. The aim has been to illustrate, in a very complete manner, such typical forms as experience has shown to be suitable for school use. Some of the pictures complement or supplement those given in "Elementary Woodwork."

The illustrations, showing the various positions of the workers as well as the methods of clamping the work, illustrate general principles, and should be so understood rather than imitated in detail; yet great care has been taken to have every illustration correct in detail, as well as in general principle.

To encourage the use of judgment and freedom of choice is the author's reason for giving more than one view of similar operations. A variety of illustrations of similar operations must not be understood to give unlimited license in the use of tools, for there is a best way to perform each operation; and no pupil or teacher should be satisfied with any but the best.

The fact that many who are considered skilled workmen frequently use their tools in ways differing from those shown in these illustrations, is not sufficient reason for rejecting the methods employed in this book. Many workers use tools improperly because they have never been taught the correct way of handling them; or because the habit of improper use has become so fixed that they do not wish to change. That every method of work given in this book is in actual use by many of the most intelligent mechanics in this line of work is a fact that should not be lost sight of.

SELECTION AND ARRANGEMENT OF MATERIAL

Face Marks. The first point to be considered in cabinetmaking is the selection and arrangement of the material. Cabinet woods are expensive, and all are subject to defects. This renders the selection of perfectly clear pieces almost impossible.

It remains for the cabinetmaker so to select and arrange the material that the defective parts will be entirely hidden or placed where they will be the least seen. After all has been done to place the defects where they will not be noticed, there may yet remain parts that will require patching, puttying, staining, or other treatment in order to present a correct appearance.

When much material is to be removed in working a piece, it is usually wise to select the best side and the best edge as the faces. After jointing them by removing as little material as possible, dress the piece to nearly or quite the exact size. Examine every part of the piece carefully and, if necessary, change the face marks to other sides and carefully square the new face corner.

Before finally determining the face surfaces, you must consider carefully whether or not the face side and edge will be those most noticeable in the completed articles. The idea of a face side must not be confused with the idea of a finished side or a best side or a side containing the best material. A face side or face edge or face corner is the one from which the measurements are made, and the one against which the head of the square is placed. The nature of the framework determines whether the face sides shall contain the best or the poorest of the material.

As the final appearance of the piece is largely determined by the selection and location of the working faces, all possible care should be exercised in their selection. In each article (similar to the stool, Fig. 113) the face corner of each leg must be on the inside, so that the adjoining horizontal pieces will be at right angles, each being joined to a face surface. If either of the three remaining corners were to be the face corner, only one or neither of

the pieces would join a face surface, and the joints would probably be poor or the stool out of square.

In jointing the face surfaces be very particular to get the piece out of wind, and also free from small irregularities. When the pieces are placed together, a joint may be spoiled by a very short curve on the face of the piece. Such a surface may throw the entire piece out of true and cause much work. Do not attempt, therefore, to lay out the pieces until the faces are straight. A little time spent in the beginning on this part of the work will save much time later on.

In selecting the face surfaces on the horizontal pieces, they should be so arranged that they will face each other. Usually the upper edge should be the face edge and also the better edge. However, when the piece is to be covered with leather or upholstering of any kind, the upper edge may be the poorer edge. If the piece has a streak of sapwood on one edge, it is usually best to plan so that the upholstering will cover the sapwood. The importance of this selection always depends largely upon the nature of the finish which is to be given to the piece.

If the article is to be finished in the natural wood, using only oil, wax, or some transparent finish, the sapwood must all be so placed that it will not show; and pieces which contain streaks should be discarded if they can not be so arranged. If some of

the darker stains are to be used, a little sapwood may show on the outer sides, and when paints or very dark stains are to be used, the sapwood may be used for any part. This applies only to such woods and stains as will color evenly on both sapwood and body-wood.

Some hard-wood and many soft-wood saps will absorb finish so much more readily than the body-wood, that after staining they will appear of a very different shade than the body-wood. If you are not certain how the finish will act on the piece of wood you are working, take a scrap of the wood and test it before selecting the pieces. Finish the scrap carefully with plane, scraper, and sandpaper, or your test may deceive you.

MORTISES AND TENONS

Methods of Joining. From your study of "Elementary Woodwork" you have learned of several forms of mortises and tenons. Now that you are familiar with the forms of these joints, you should be able to combine them in the construction of framework for various purposes. Do not make the mistake of thinking that you can learn to make the joint and combine it at the same time. When you are studying the methods of combining parts, you will have quite enough to attend to without attempting at the same time to learn

how to make joints. If you have not made each of the forms of mortise and tenon as given in "Elementary Woodwork," do so before attempting to lay out any piece of furniture. This will save time and material, and assure you better work and larger benefits in the doing. For convenience in explaining the various methods of laying out mortise and tenon work, we may divide the various forms of construction into two classes: First, those in which the piece is flat like the back of the large armchair (Fig. 1); and second, those which constitute a framework similar to the footstool (Fig. 119).

Each of these classes may be divided again into those which are forced together all in one direction, as the backs of the chairs (Figs. 150 and 159), or the sides of the chairs (Figs. 124 and 147), and those which are forced together in two directions, as the back of the chair (Fig. 146) and the back of the hall seat (Fig. 162).

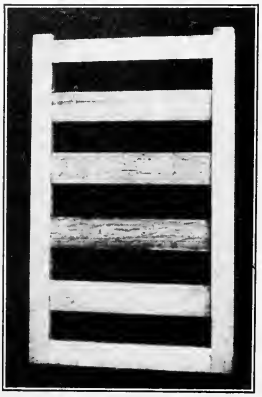


FIG. 1. *Armchair back*

You will readily understand that the joints in the first class are the easier to make, and also that those which are joined all in one direction are the easier forms of each class. This should be considered when you select your project.

All parts to be joined must first be dressed true on one face and on one edge. Usually, the other two surfaces are also jointed, yet this is sometimes omitted until after the parts are fastened together. In studying these forms of joining, we will consider first the making of tenons of the simple forms and the mortises used with them (Fig. 1), following these, in order, with directions for making such as are more difficult.

Tenons. In designing chairs and tables, the sizes and arrangement of tenons are of considerable importance.

The arrangement of rails in Fig. 119 is such that the tenons meet in the legs, and consequently are not so long as they are in Fig. 122, in which they are arranged so that they do not meet. As the latter arrangement is considerably stronger, it should be used wherever it will be in keeping with the design.

The sizes of tenons need not follow an exact proportion to the size of the piece, but should be kept usually to certain standard dimensions in order to make the laying out more simple, as well as to avoid the use of a large variety of bits and chisels. This simplifying of sizes may be accomplished without any loss to the design or in the value of the exercise.

For pieces $\frac{7}{8}$ inch by 4 inches, and similar sizes, the tenon may be $\frac{3}{8}$ inch by 3 inches, or the next inch less in width below the width of the piece. If

the width is less than $2\frac{1}{2}$ inches, the tenon may be the first $\frac{1}{2}$ inch less in width than the width of the piece. Thus, if the piece is $3\frac{7}{8}$ inches wide, after the tenon is worked to $\frac{3}{8}$ inch thick and one edge of each tenon gauged, the gauge should be set to $3\frac{1}{2}$ inches and the other edge gauged. The small variation in width from 4 inches should not be considered in making the tenon, and whatever variation there may be should be left at the back edge of the piece. This method not only simplifies the work, but also gives better results. This plan, however, cannot be used in places where equal spaces are required at each side of the piece, as in the back of some armchairs. In such places the tenons must be in the center of the piece. These exceptions are few compared with the many places in which the regular method may be used.

The same principle should be followed in gauging for the thickness of a tenon. If a tenon is to be $\frac{3}{8}$ inch thick on the end of a $\frac{13}{16}$-inch piece, set the gauge first to $\frac{1}{4}$ inch and then to $\frac{5}{8}$ inch, having the back shoulder but $\frac{3}{16}$ inch. If the piece were $\frac{7}{8}$ inch, the back shoulder would be $\frac{1}{4}$ inch, the same as the one at the front side.

Mortises for Chair Backs. In Fig. 2 is shown how the two long sides, or stiles, of the back of a large armchair are laid side by side, face edge up, and with the face surfaces together or both outside. If one were outside and the other inside, the pieces

would not face correctly when laid flat (Fig. 3). A clamp may be placed on the pieces in a manner similar to Fig. 11; but if you are careful you can dis-

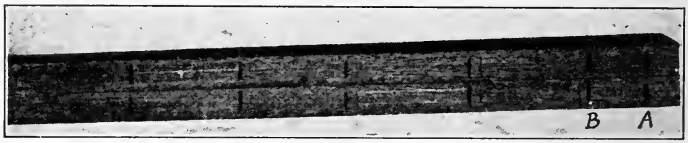


FIG. 2. *Stiles—side by side for lining*

pense with the clamp unless you have more than two pieces to hold at the same time.

Measure all of the pieces to see how much waste material may be cut off, and leave about half of this waste at each end.

FIG. 3. *Stiles—flat, showing face marks*

Before marking the length of the mortises, examine the short pieces, or rails, to see whether any change in the size of the tenon is required. Notice the difference in the location and size of the mortises at the top and bottom ends (Fig. 5, *A* and *B*). This is because at the top the stile projects beyond the rail and the mortise is not likely to cause the end to split. There is no projection of the stile at the

bottom, and therefore the mortise is set farther away from the end. If the rails are full width, begin to lay out the mortises by drawing a line for the edge of the mortise next the end, on each stile (Figs. 2, *A* and 4, *A*). Then measure the width of the mortise and draw a line on each stile for the other edge (Figs. 2, and 4, *B*). Measure the total length of the stiles, and draw a line across their bottom end. Measure from this line to the lower edge of the mortise and draw lines (Fig. 4, *C*). Lastly, draw the lines for the inner edge of these mortises (Fig. 4, *D*). Locate the other mortises and draw lines for each edge. In drawing all these

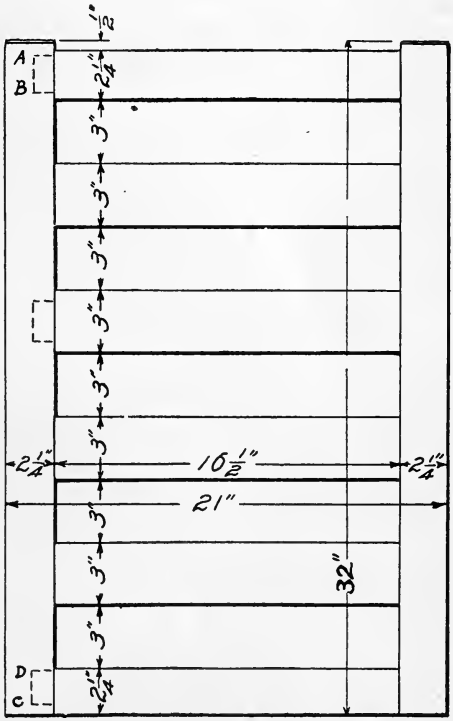


FIG. 4. *Armchair back*

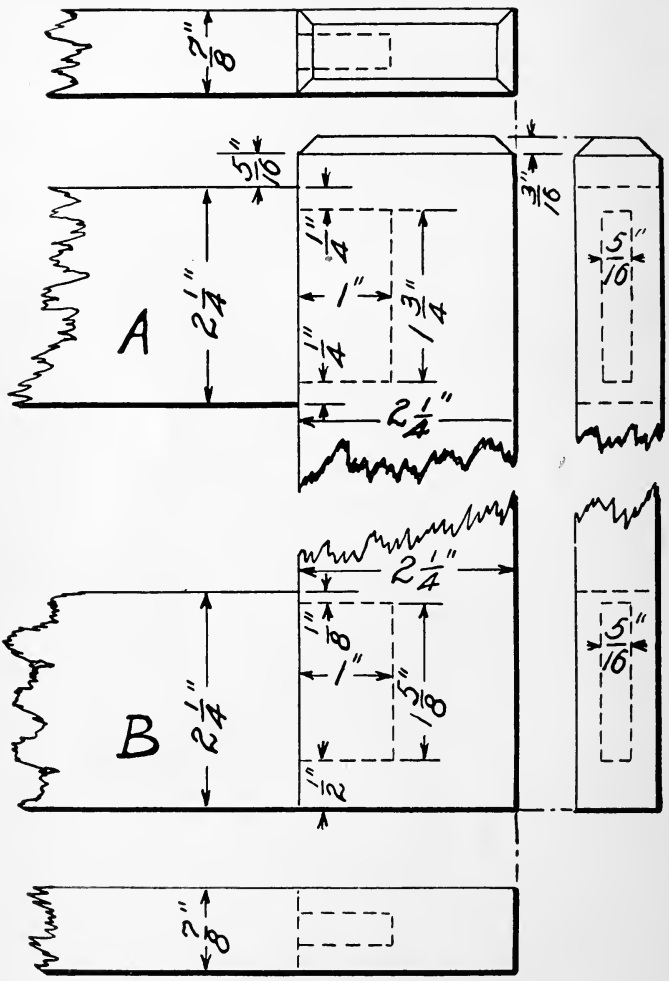


FIG. 5. *Detail of corner joints*

lines, be careful not to draw them entirely across the piece, for if you do, they will show badly after the parts are put together. This is especially true of the mortises for the ends of thin pieces (Fig. 2). After you have become familiar with the methods of laying out such work, you will measure all the spaces at one time and then draw all the lines. In this way you avoid changing tools so often.

Tenons for Chair Backs. After the lines for the ends of all the mortises have been drawn, clamp the rails side by side, all the face edges down and the face sides of the upper and lower rails together. This is done so the face marks will be on the same side as the stiles and both face edges on the inside.

Be sure that the clamp ends do not touch the bench, but are far enough back from the edge to allow the head of the try-square to move along the edge (Fig. 6). Place the clamp in the vise, then measure on the edge of the rails the space between the stiles, and draw lines as shown in Fig. 7. If the rails are too long, do not allow

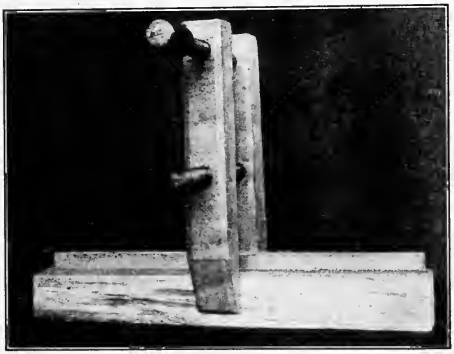


FIG. 6. *Placing clamp on rail*

for cutting off at each end, but place all the pieces even at one end and cut all the waste from the other end. If any piece is a little short, divide the amount between the two ends. A slight variation in the length of the rough piece is often unimportant.

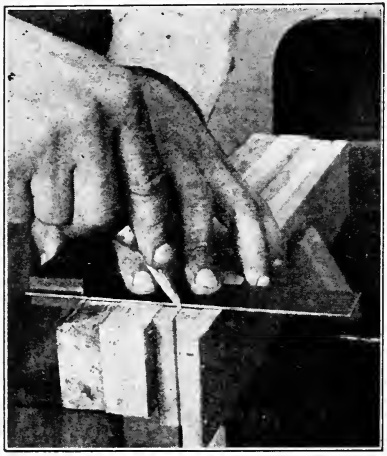


FIG. 7. *Drawing lines*

The tenons at the ends of the thin pieces will be strong enough if they are only one-half inch long.

After lines are drawn at which the waste is to be cut off and also at the inner ends of the tenons, remove the clamp and draw lines entirely around each piece, as you do in making a blind mortise and tenon. (Elementary Woodwork.)

Set the marking gauge first, for the lines nearest the face side and draw the lines for all the mortises and for the tenons on the upper and lower rails. Then set the gauge for the lines farthest from the face side, and draw the lines for the other side of the same mortises and tenons. Set the gauge again, and draw the lines for one side of the tenons on the thin pieces. Then set the gauge for the other lines,

and draw a line on one end of the piece. Lay the end on a mortise and see if the line is correct (Fig. 8). If it is not, adjust the gauge until the lines coincide with those of the mortise, and then draw the remaining lines. A mortising gauge will avoid the trouble of so much resetting. (See what is said about this gauge in Part III, page 267.)

After the tenons have been worked to correct thickness, gauge them to width. Be sure to draw all the lines with the head of the gauge against the face edge.

The tenons should fit to place without driving, but tight enough to require considerable force. Place the parts together in the clamps before applying any glue (page 84). See that every joint is perfect on both sides, then remove the pieces and smooth and finish them as directed on page 79 before applying the glue.

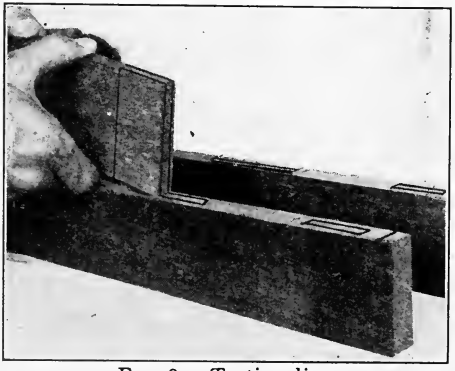


FIG. 8. *Testing lines*

Length of Slats. In laying out work like the backs of Figs. 154 and 156, the sides and ends are lined in the same manner as Fig. 1. After the four

joints at the corners are finished, the pieces are placed together as shown in Fig. 9, and the space between the tenons on the slats is marked. This is a safe way to locate the lines. The length between the tenons may be found by measuring the space between the mortises on the stiles, and then subtracting the space from the edge of the tenon to the inner edge of the rail. In Fig. 156 it will be $27\frac{1}{8}$ inches—the distance between the mortises less $\frac{1}{4}$-inch shoulder at the upper rail, and $\frac{1}{8}$-inch shoulder at the lower rail, making the length between the rails, or the length of the slat between the tenons, $26\frac{3}{4}$ inches. This may be verified by laying the rails in position and measuring between them. Unless the slats are too thin, make the tenons $\frac{5}{16}$ inch thick. You will discover that this size is easier to work than if they were thinner. This thickness also corresponds with that of the tenons on the ends of the rails. Were it not for the slats the tenons at the corners would be made $\frac{3}{8}$ of an inch. Locate and work the mortises as any other blind mortise.

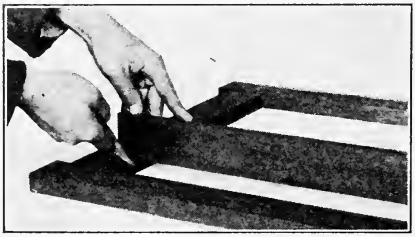


FIG. 9. *Measuring vertical pieces in chair back*

Do not attempt to glue the slats in place before placing the stiles in position. Test all in the clamps

before gluing any portion. Remove the clamps and smooth the surfaces as directed on page 79; then glue all at once, clamping as shown in Fig. 66.

After the glue is dry, finish the outside surfaces as directed on page 83. See that both sides and ends are of equal thickness, also chamfer the upper ends of the stiles (Fig. 156.) The lower ends are dressed flush with the lower rail. Be careful not to make the chamfers too large, and be particular to have them all alike. (Directions for "Chamfering," page 43.)

Laying Out Tenons for Chair Frames. If the tenons are to enter blind mortises, there is no need of truing the ends of the pieces or of drawing lines at the ends. The pieces should have been cut to the proper length in cutting up the stock.

When the pieces are all of the same width, place them face edge up, and even the ends, as shown in Fig. 10. Place the clamp and try-square as shown in Fig. 11.

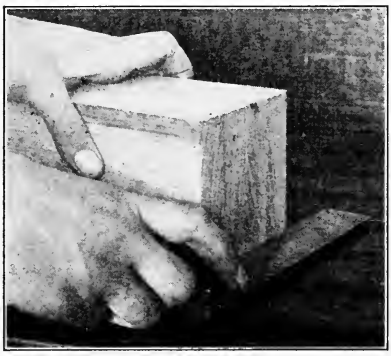


FIG. 10. *Evening pieces*

In locating the lines for the inside ends of the tenons, lay the rule on the piece and determine how much stock can be used for the tenons. If the pieces

are so long that they will need to be cut off, plan to cut all from one end; if they are a little scant, divide the material between the two. Tenons which are to enter blind mortises need not be all of exact length. It is a waste of time to attempt to make them exactly the length given in the drawing. They should always be made short enough not to reach closer than $\frac{1}{8}$ inch from the rough bottom of the mortises in an ordinary chair or table leg.

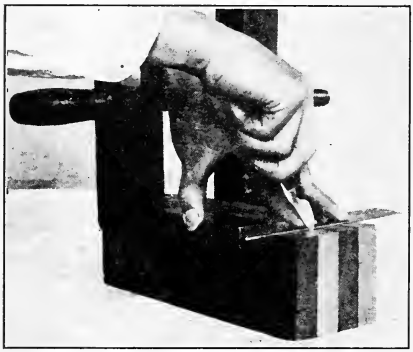


FIG. 11. *Drawing line*

If the clamp is in the way of the try-square in drawing the second line, place a second clamp on the pieces (Fig. 12), then remove the first one and use the try-square again (Fig. 11). Compare these directions with those given on page 21.

Before clamping pieces together in this manner their sides must be parallel. If for any reason they are not parallel and cannot be made so, only one piece should be lined at first; then this piece should be laid upon each of the others and the spaces marked from it (Fig. 13). Do not attempt to measure each piece separately with the rule.

After drawing a line entirely across each end, remove the clamp and complete the lining on each piece separately.

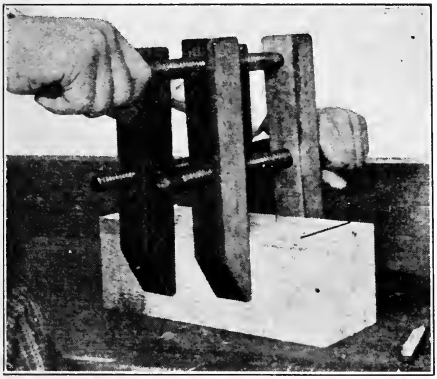


FIG. 12. *Exchanging clamps*

Set the gauge and draw the lines nearer the face side for all the tenons, drawing a line on each edge and across the ends. Set the gauge to the distance of the back side of the tenon from the face edge, and complete the lining. Saw and chisel the sides of the tenons. You will save time by doing the sawing for all the tenons at one time. After the sides of all the tenons are finished, gauge them all to width. Remove the waste with saw and chisel. These tenons are made $\frac{1}{2}$ inch thick because they enter a piece which is more than 1 inch thick. (For further information see what is said concerning "Tenons," pages 16 and 21.)

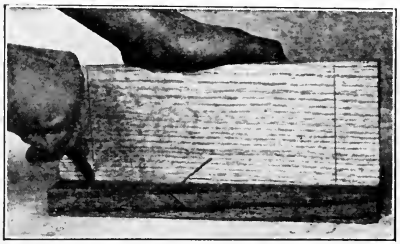


FIG. 13. *Marking by superposition*

Mortises for Footstools. Clamp the pieces together the same as the rails (Figs. 10 and 11), and draw the lines for the mortises in the same manner as before directed for tenons.

Draw the knife lines only a part of the way across the piece, for if the lines are much longer than are required for the mortise, their ends will be visible after the work is finished (Fig. 2).

Draw lines entirely across the piece for the finishing of the ends.

If there are other lines or marks which need to be alike on all the pieces, make them while the pieces are clamped together. If there is a chamfer at the end, draw lines for the chamfer with a pencil.

Remove the clamp and draw the lines at the ends entirely around. If the mortises are alike on both sides, carry the lines around for the other mortises. If the mortises are not alike on both sides, place the pieces together so as to lay out the mortises at the other side, and clamp and line them in the same manner, except that, in this case, instead of evening the ends with the try-square, you adjust the pieces to the line at which the ends will be cut off.

If there are no lines at the ends, small marks may be made at the corners opposite the ends of the mortises, and the pieces adjusted to these marks in clamping the second time.

In cases where the mortises are not alike on all sides of the legs (Fig. 122), they may be set on end

(Fig. 14) in the relative positions they will occupy when completed, and sketches may be made with a soft pencil on each surface showing the relative position for each mortise or other joint. Sometimes the top ends, the position of arms, and other details, require being indicated in this way.

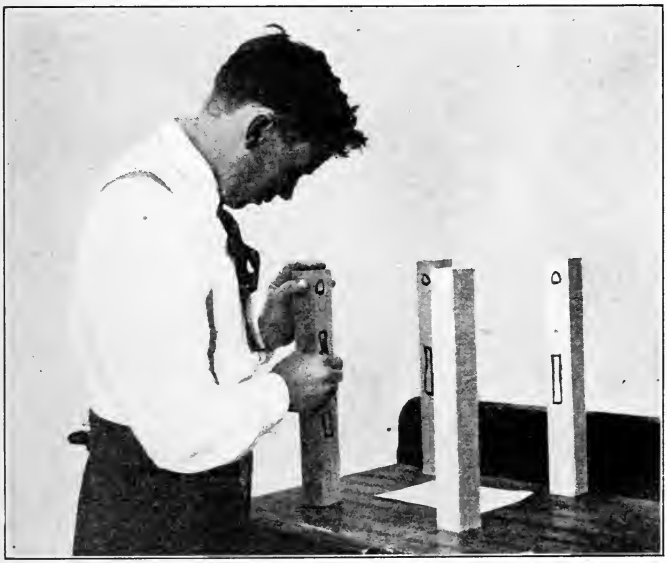


FIG. 14. *Sketching position of mortises*

Do not attempt to mark these places exactly. A free-hand sketch indicating the places is all that is required or necessary, as the pencil marks are simply to avoid making the mortises on the wrong sides or at the wrong ends.

After the knife lines for all the mortises are drawn, set the gauge and draw the gauge lines nearer the face edge for all the mortises. When this is done set the gauge for the lines farther from the face edge and draw all these lines. As soon as the gauge has been set for the second side of the mortise, test it by drawing a short line and compare the space with the width of the tenon, similar to the test shown in Fig. 8. Bore the holes and work the mortises the same as in working the blind mortise. (Elementary Woodwork.)

You will save much time by laying out all the mortises and boring all the holes at one time before doing any work on the mortises with the chisel. Be careful to have every mortise of the proper size at the bottom end and also square with the surface. The squareness of your work depends very much upon your mortises, therefore you should be very careful to make them correct.

Testing a Mortise. There are many makeshifts employed by inexperienced persons to determine whether a mortise is square with the surface and of the same size at top and bottom. Do not get into the habit of using such devices. Be very careful to bore the holes straight, and they will aid you at first in working the mortise. After the sides are nearly finished, use the edge of the chisel against the side and also against the ends of the mortise as described in "Elementary Woodwork."

Do not attempt to work the mortise, even in soft wood, without boring holes, and bore as many holes as are required to leave but a very small amount of waste material at either end of the mortise, and between the bit holes. Be sure to bore the two end holes quite near to the end of the mortise, even if you are obliged to bore both end holes before boring all of the other holes.

Use a chisel a little narrower than the mortise for working the ends. The sides may be worked with a $\frac{7}{8}$-inch chisel no matter how long the mortise. A wider chisel might be used, but in most cases it is not worth while to get it from the tool room for the very small saving in time, and besides you will learn more by using the $\frac{7}{8}$-inch chisel.

Mortises in Chair Legs. If the pieces are not straight, they cannot be handled in the same manner as are the footstool legs (page 28). To lay out the mortises on legs for chairs similar to Figs. 124 and 147, it is necessary to sketch first the positions of the mortises, as on the stool legs (Fig. 14), and then to lay all face down on the bench the same as you do the rails (Fig. 10). Be sure to set the clamp far enough from the edge to allow room for the try-square head (Fig. 6); then place the clamp in the vise (Fig. 15), and lay off the mortises. The location of the mortises in the back may be determined by first making marks at the corners and then carrying these marks across the edge after the clamp has

been removed. These marks, much exaggerated, are shown in Fig. 15, as are also the lines on the edge.

If the mortises on the other sides of the legs are the same as on this side, the lines may be carried around after the clamp has been removed. If they

FIG. 15. *Lining chair legs*

are not alike, small marks locating them should be made at the corners before the clamp is removed.

The proper corner in which to place the marks is indicated by the position of the visible face mark.

The legs may be clamped together; the two back ones side by side with their face marks together, and the two front ones also side by side and their face marks together, but this need not necessarily be done if they have been properly straightened and squared. Those photographed were placed with the front legs at the center to show the lines on the back legs.

After the ends of the mortises have been located, they are lined and worked the same as those in footstool legs (page 30).

In locating the side lines for the mortises for the two back rails, place them so that the top edge of the upper rail is near the center of the width of the leg at the top, and draw gauge lines parallel with the face from these points, making both rails of equal distance from the face.

Keyed Construction. Whether joints held in place by wooden keys are a mark of superior workmanship or a relic of past times, like the ox cart and wooden plow, must be decided by each person according to personal preference and understanding.

Many of the articles illustrated in this book may be joined by using one or more keyed tenons. The footstool (Fig. 119) may have the long side rails secured in this manner. In Fig. 123, all of the rails may be keyed because they are so arranged that all may pass entirely through the legs.

In the chairs, a part of the tenons may be keyed and a part left blind, as shown in the figures. In

Fig. 128 keyed tenons may be used on the top and bottom back rails and the wide front rail. For pieces of this width, the tenon and key should be about the proportions given in Fig. 16.

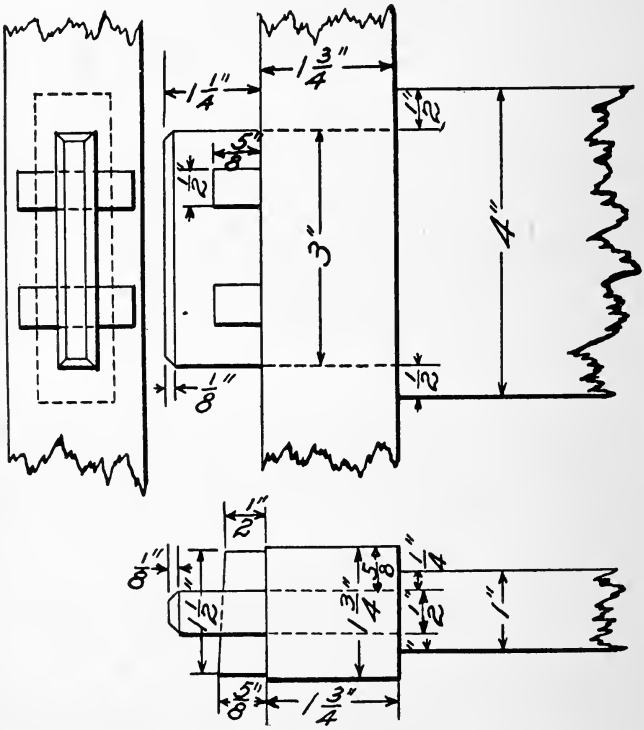


FIG. 16. *Tenon and key*

Figs. 87 and 190*d* give other suggestions as to sizes of keyed mortises and tenons.

Doweling. Before deciding whether the parts should be joined by mortises and tenons or by dowels, you should consider the nature of the material, the sizes of the parts, the strength required, and the amount of labor to be put upon the article.

To say that dowels mean inferior workmanship is certainly incorrect; they are sometimes, but not always, better than tenons. On thin or soft wood they are generally better than mortises and tenons. In the desk (Fig. 211) where the edges of $\frac{7}{8}$-inch pieces are joined, dowels are better than tenons. This is especially true in joining the upper rail, as the dowels in the ends of this piece are sure to hold better than one or two tenons at each end. Were the upright pieces $1\frac{3}{4}$ inches thick, probably a mortise and tenon would be better.

Dowels are often useful in other places—in connecting the upper and lower parts of the desk (Fig. 211), and also in securing the arms to the top of the chair legs (Fig. 150). Dowels should not be used in glue joints.

CHAIR AND STOOL LEGS

Different Kinds of Legs. Legs for chairs and footstools may be divided into five classes or kinds for convenience in describing methods of making them. The first of these classes includes those which are rectangular in section, sides parallel and straight

FIG. 17. *Straight rectangular leg*

FIG. 18. *Bent rectangular leg*

(Fig. 17); the second, those which are rectangular in section and straight and tapered all or a part of the length (Figs. 188 and 21); the third, those which are not straight yet are of rectangular section and without curves (Fig. 18)—curved legs are not treated in this volume; the fourth, those which are turned a part of the length (Fig. 19); and the fifth, those turned the entire length (Fig. 20). A part of a leg can be turned to a plain cylinder, and dressed by hand to an octagon or a hexagon.

FIG. 19. *Part turned leg*

FIG. 20. *All turned leg*

The first step in working any of the forms, except those which are turned the entire length, is to dress a face side. This face side is on the inside, or invisible side,

of the piece when the chair or footstool is completed. It is, therefore, the surface which ought to contain the defects. (See what is said about face sides under topic "Face Marks," page 11.)

Rectangular Legs. Legs of the first class are shaped by the same method of working as is used in squaring the first piece. (Lessons 1 to 5, "Elementary Woodwork.") If the ends are not finished until after all the mortising has been done, there will be less liability of the corners being injured.

Tapered Legs. In making legs of the second class, which are tapered the entire length, the face side and face edge are jointed by the methods given in "Elementary Woodwork" (Lessons 1 and 2). After these two faces are straightened, the third surface is lined by marking the width at each end, and using a straight edge with which to draw a pencil line. The fourth side is marked in the same manner, either before or after the third side has been finished. The surplus material may be removed either by planing or by ripping and finishing with the plane.

FIG. 21. *Tapered leg*

If the taper extends but a part of the way (Fig. 21), the piece is made straight and square on all four sides for the entire length; then the lines are drawn for the taper, and the piece is worked to these lines. If all four sides are to be tapered

(Fig. 21 or Fig. 188) to make the lining easier, you should line and taper two opposite sides first and then the other two sides. If the leg is to receive a mortise near the tapered part, it is usually better to do the mortising before doing the tapering. This method is also better in making short legs, such as those for footstools (Figs. 113 and 117). The amount of taper given legs for chairs, tables, and other articles, may vary from $\frac{1}{8}$ inch at each side, as in Fig. 21, to any amount that you may wish. Usually, on small legs the smaller amount is to be preferred. The greater taper may appear well at first but in time such pronounced forms become tiresome.

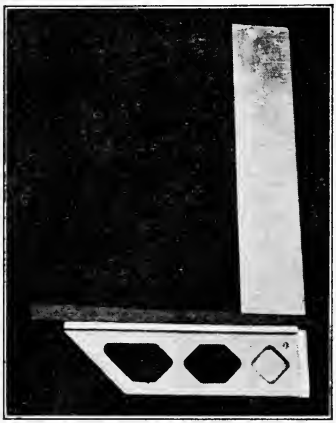


FIG. 22. *Tapered piece on head of try-square*

On legs which are tapered the entire length (Fig. 188), a tapered piece may be used under the head of the try-square (Figs. 22 and 23). Use these in laying out the mortises, and in lining the ends of the rails, as they must correspond to the taper of the legs. To make this piece, select a piece of hard-wood about $\frac{1}{2}$ inch square, and with the ripsaw cut a kerf in it about two inches long. Taper the piece and slip it over the try-square blade.

After the legs have been smoothed and the tapers finished, test the try-square and tapered piece by applying them first to one side and then to the other, and changing the taper, if need be, until lines drawn from either side will coincide.

The tee bevel may be used in a similar manner, but this is so often accidentally changed, and is so difficult to use, that the tapered strip, as described, is usually better.

Legs of the Third Class. Legs of the third class are more difficult to make because the plane will not cut readily at angle *H*, Fig. 24. These legs may be laid out by drawing lines as shown, but it is usual to lay out a thin piece of board in this manner, and then use it as a pattern. This will save time if more than one pair of legs is to be made, and will also save material, for the pattern can be laid on the stock and tried in several positions until the best place is found. If only one pair of legs is required, time will be saved by jointing the face side before they are cut from the stock. If they are cut out before the face side has been

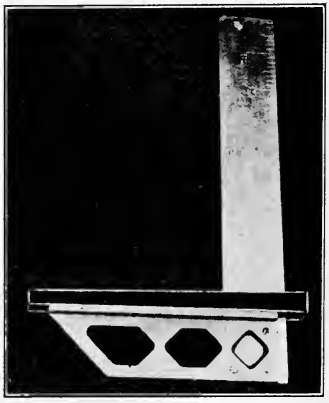


FIG. 23. *Tapered piece on head of try-square*

made straight and out of wind, they can be examined by holding the same as in sighting a straight piece in working the first surface. Care must be taken to have the surface *A* (Fig. 24) straight from end to end before looking for wind. After this surface is correct, finish surface *B* (Fig. 24) and mark it, then surface *C*.

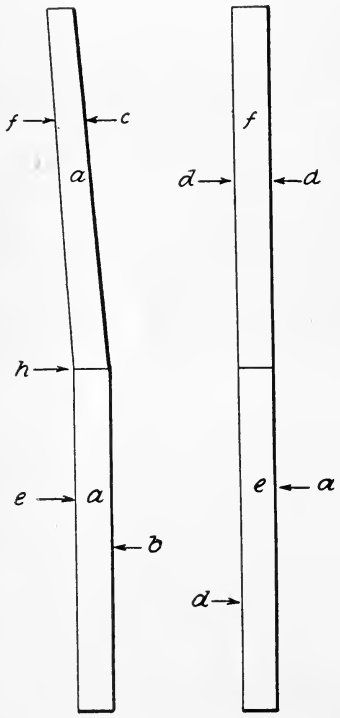


FIG. 24. *Back chair leg*

Set the gauge for the thickness and gauge entirely around the piece, the head of the gauge resting against *A*, which is the face edge. Dress the surface *D*; and then, with the gauge set the same as for the thickness, gauge for surface *E*, which is opposite *B*. Mark the width at the top end, and with a straight edge draw a line for the surface *F*. Plane *E* and *F*, turning the plane when near the angle *H*, as shown in Fig. 25.

Run the plane straight, as near as you can. It is not necessary that the angle be finished entirely

to the line. It is much easier to leave about $\frac{1}{32}$ inch at the vertex; and this also results in a better form.

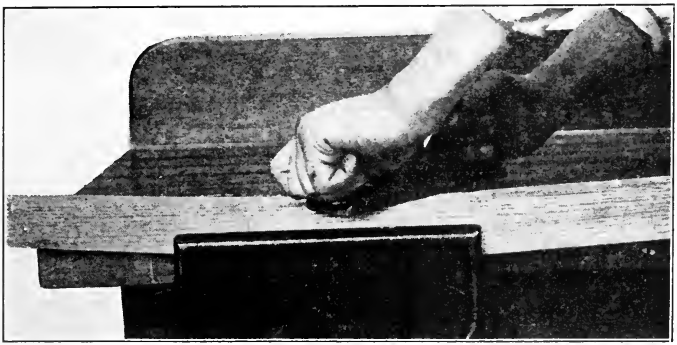


FIG. 25. *Planing angle of leg*

The slight roughness caused by planing across the grain can be removed with a scraper when the final smoothing is done.

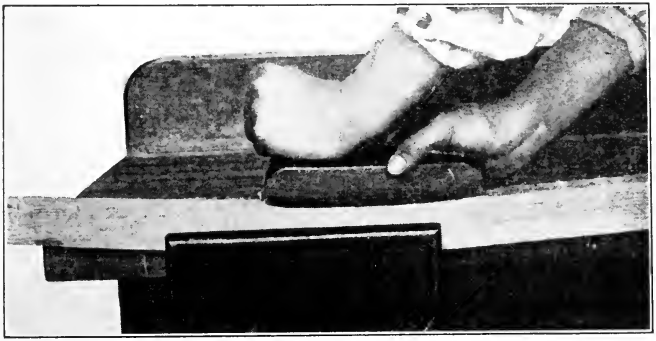


FIG. 26. *Using round bottom plane*

When many legs of this type are to be dressed, a plane may be fitted especially for the work. This may be done by attaching a false bottom to a plane, or by rounding the bottom of a plane. A wooden bottom Bailey plane, rounded for such use, is shown in Fig. 26.

Legs of the Fourth Class. The fourth class, or legs turned a part of their length, may be squared either before or after turning. Usually, it is better to have the blanks carefully squared in the machine, and the hand-jointing of the pieces done after the turning has been completed.

In planing the sides after turning, care should be taken not to make any flat places on the turned part of the pattern. To avoid this, all turned surfaces should be a little below the surface of the square.

Legs of the Fifth Class. The fifth class, or legs which are to be turned their entire length, ought also to be squared in the machine, as this will assist in sizing them and avoid mistakes in centering and selecting the top end. Such legs should be so shaped that the rungs may enter the larger parts of the pattern as shown in Fig. 20.

Finishing Ends. As the ends of pieces are often quite conspicuous, the style of finishing them is very important. The most common form, known as a chamfered end, is shown in Fig. 27. Another form, the rounded end, is shown in Fig. 28. Occasionally, the tapered end shown in Fig. 29, is used.

The methods of working all the forms are similar. Pencil lines should always be used instead of knife lines in laying out the ends for any of these forms of finish, as a knife line may remain visible after the end has been finished.

FIG. 27. *Chamfered end*

All of these forms should be carefully sandpapered. Do not use sandpaper on a block for this purpose, but use it in the hands as shown in Fig. 30. If the end is quite large, a block may be used on edge for a part of the sandpapering. Be sure that it does not extend over the edges, for if it does, it will certainly spoil the lines that should be sharp and clean cut.

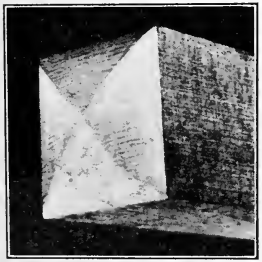


FIG. 28. *Rounded end*

Chamfering. In making the common chamfer (Fig. 27), lines are drawn on the sides and on the end, an equal distance from the corner. For legs $1\frac{3}{4}$ inches square these lines should not be more than $\frac{1}{4}$ inch from the edge; on $\frac{7}{8}$-inch pieces, these lines should not be more than $\frac{3}{16}$ inch from the edge, and in many cases, $\frac{1}{8}$ inch is better.

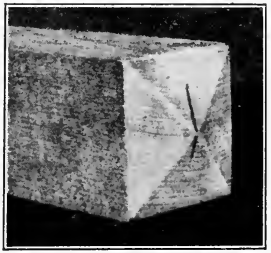


FIG. 29. *Tapered end*

FIG. 30. *Sandpapering end*

The lines should be carefully drawn and the chamfered surface exactly straight in both ways. The chamfers should be exactly alike, as the least variation shows badly. Hold the plane as in chamfering the pieces for the bench-hook (Elementary Woodwork), so that the corners will not split.

Tapered End. The tapered end is made in the same way, except that the lines on the ends are drawn across the center, as shown in Fig. 31, and the surface is worked to these lines. After two opposite sides are finished (Fig. 32) the other sides are worked to shape, giving the form shown in Fig. 29.

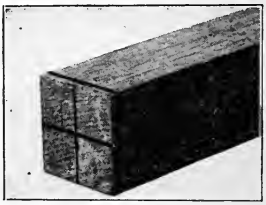


FIG. 31. *End lined*

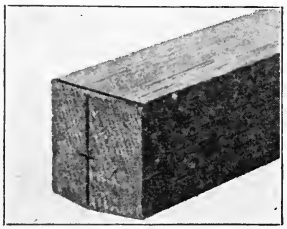


FIG. 32. *Two sides of end worked*

Rounded End. The rounded end (Fig. 28) is made in the same way as the tapered end, except that the surfaces are planed to a curve instead of being planed flat. This is a very difficult form to make.

PANELING

The Best Methods of Paneling. There are many ways of doing paneling, but for all ordinary work, the following methods are best.

The chief difficulty with paneling is, that unless every piece is carefully jointed so as to be straight and out of wind on the face surface, and straight and square at the face edge, the panel will be in wind when the pieces are all together, and there is then no way of getting it out of wind.

If each step in the work is properly done the panel will be flat and square. Usually the outer edges and back sides of the stiles and rails are not jointed until after the parts are put together.

Two Important Methods. There are two important methods of making paneling, and you must decide which you will use before beginning work. The first, and the usual method in manufacturing establishments, is to cut the groove for the panel the entire length of both rails and stiles. This requires a haunched mortise and tenon, or, as is often the case in cheap work, a tenon only as long as the groove is deep and fitting it in width. The other method is to make the joints at the corners the same as if no groove were to be cut, and then to plow the rails full length and work the grooves in the stiles only so far as is necessary to receive the panel. As this cannot be done with the plow, it

requires considerable time. If the stile is long the groove may be worked a short space at each end with gauge and chisel, and finished with the plow. In working a groove with a chisel, score it similar to working the rabbet (Fig. 230).

If the groove is to extend the entire length of the stiles and the haunched tenons are to be used, the mortises and tenons should be worked before plowing the grooves. They should be so placed that after the grooves are made, the mortises and grooves will be in line. Usually, the tenon should be the same width as the groove.

The manner of laying out and working the mortises and tenons is the same as described in making the back for the chair (Fig. 1), except when the tenon is haunched instead of plain. This style of tenon is described in "Elementary Woodwork." In other respects the sizes of joints are the same as in similar sized stock for other places. Dowel joints are often much better than mortises and tenons for paneling. Holes for the dowels may be bored and then the stiles and rails grooved the entire length without regard to the location of the dowels. A plug would then be used in the ends of the grooves which are visible after the parts are together.

Plowing the Groove. After the mortises and tenons have been worked, set the plow (Fig. 281) and make the groove for the edges of the panel. Be particular to have the fence of the plow on the face

side and the groove in the face edge. Note carefully what is said under the topic "Face Marks," page 11, before beginning to make the grooves.

For ordinary panel work in $\frac{7}{8}$-inch thick stock the grooves should be $\frac{5}{16}$ inch wide and $\frac{3}{8}$ inch deep. These sizes should be used, unless the size of the stock makes some other size of groove necessary.

You will see by referring to Figs. 216 and 217 that it is not necessary to locate the panel in the center of the edge of the stile, nor that the stiles and rails should be of the same thickness or width. For convenience in working, the stiles and rails are usually flush on the face side. The sizes for the various parts used in paneling are indicated by those given in the drawings (Figs. 34, 35, 36, and 38). These may be modified to suit any particular case.

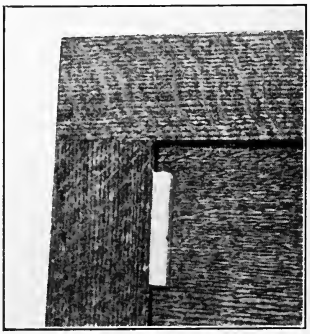


FIG. 33. *Glue block on panel*

Securing the Panel. A common mistake in paneling is that of gluing the edges of the panel to the rails. This should not be done because, if the edges are glued, there will be no chance for the panel to shrink or swell, which is an important feature in panel work. The panel should fit snugly in place, but not so tight as to spring the rails instead of moving in the groove.

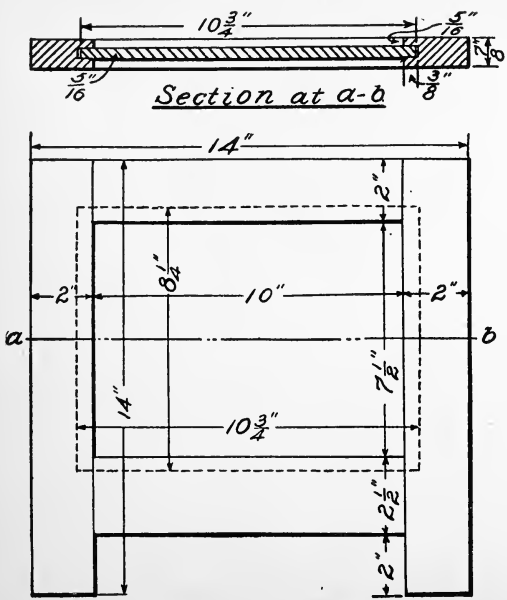


FIG. 34. *Plain panel*

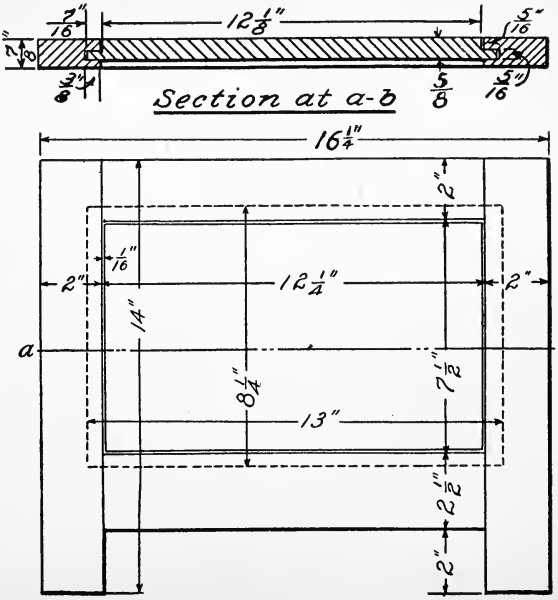


FIG. 35. *Flush panel*

A little glue may be placed at each end near the center to keep the panel from moving to one side. This is sometimes accomplished by a glue block at each end on the inside, as shown in Fig. 33. A brad driven in at the same place may do quite as well for some work.

The stiles and rails for the various forms of paneling shown may be the same, the panel being the important difference. The various forms may be grouped in any of the many combinations seen in doors, furniture, and wall-paneling.

Forms of Panels. The form to be used must be determined by individual needs and special conditions. In the shoe box and costumer (Fig. 204) are shown the four styles of panels in use. Figs. 34, 35, 36, and 38 are detailed drawings of these panels. You should have no trouble in making panels for any piece of furniture. You need only to alter the sizes given in these drawings, and then work the pieces in the same manner as directed for these typical forms.

Plain Panel. The panel shown in Fig. 34 is simply a plain board of the same thickness as the groove in the rails and stiles. It is placed in position as the rails and stiles are put together. All necessary scraping and sandpapering should be attended to before it is put in place.

Flush Panel. In making a flush panel (Fig. 35), simply rabbet around the piece so there will be an

outer edge, or tongue, to enter the groove; the remainder of the panel being of full thickness. Such panels may be finished by planing them flush with the stiles and rails after the parts are glued together.

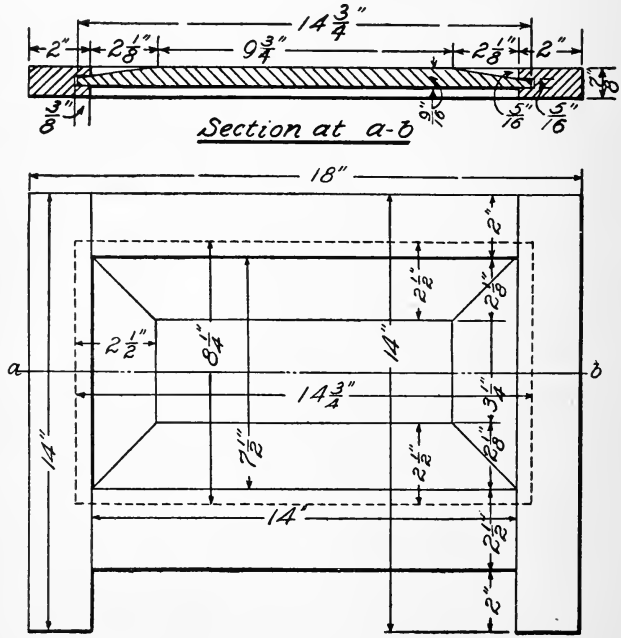


FIG. 36. *Raised panel*

If there is any likelihood of the panel swelling, a space must be left at the sides between it and the bottom of the grooves and at the edge of the stiles. No space need be left at the ends, as the panel will not swell endwise.

Raised Panel. In making a raised panel (Fig. 36), the piece is first dressed to the thickness of the thickest part of the panel, and then the central raised portion is laid out with a pencil. The thickness at the edge is marked with a gauge, and the outer portion planed to an even taper to the edges, making the edges of a proper thickness to fill the grooves at the edges.

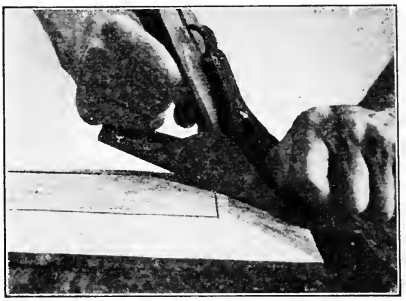


FIG. 37. *Raising panel*

In planing across the ends, the plane should be held at an angle of about 45 degrees (as shown in Fig. 37). You will notice that the piece enters the grooves about $\frac{3}{8}$ inch, and therefore it is necessary for it to be a little thinner at its edges than the width of the groove.

If both sides of the panel are visible, both may be raised in the same manner, or one may be plain. Sometimes one side is raised and the other made flush, as the outer surface of Fig. 35. This makes a very solid panel.

Elevated Panel. The elevated panel (Fig. 38) is similar to the raised panel but requires thicker stock, because it must be fitted into the groove in the framework and also be itself grooved, so that

its elevated surface will cover the edges of both rails and stiles. This is necessary to make a joint which will remain tight and which can be properly finished. Fig. 39 is a view of the edge showing the groove.

The finished surface is worked in the same way

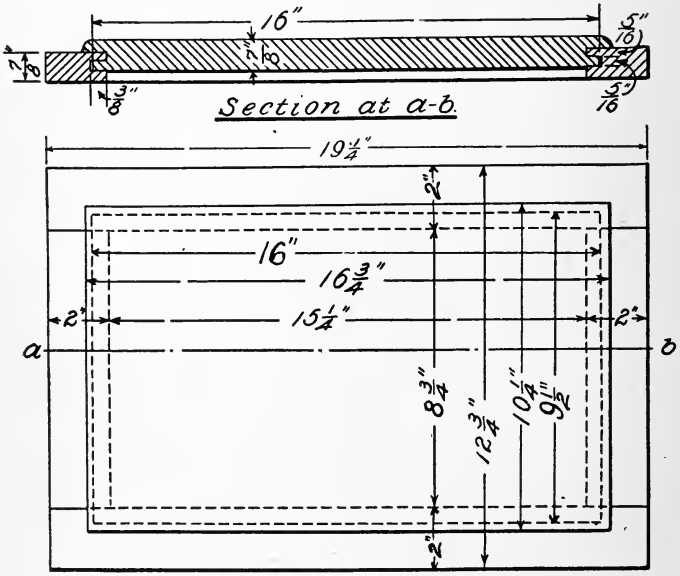


FIG. 38. *Elevated panel*

as the raised panel. It may be flat, with square edges slanted to each side and end, or oval. The panel should be finished before it is put into place.

The rails and stiles, being partly covered by the panel, must also be smoothed ready for sandpapering on the panel side before they are put together.

FIG. 39. *Edge of elevated panel*

This style of paneling is especially suitable for the tops of chests and for similar positions because it will sustain considerable weight.

THE MAKING OF DRAWERS

Kinds of Joints. When you have a drawer to make, the first thing to do is to decide on the kinds of joints you will use at the corners. The joints ordinarily used on fine work are the half-blind dovetail at the two front corners, and the common open dovetail at the two back corners. A very good joint for the front is shown in Fig. 40. A joint easier to make is the simple rabbeted joint shown in "Elementary Woodwork." The grade of work you are doing and the amount of time you may wish to spend on it, must determine your choice in selecting the styles of joints. If you use a plain rabbeted joint at the front end, the back end should be a simple square butt joint, secured by nailing.

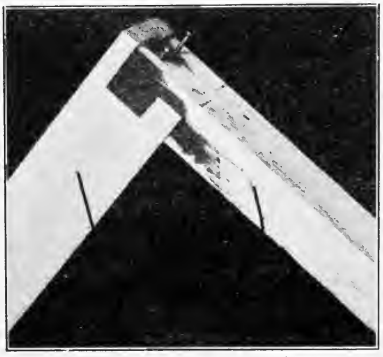


FIG. 40. *Drawer joint*

The Front. After deciding upon the styles of joints the next thing is to make the front. Be sure that it is a little too large, so you can dress off the top edge, the bottom edge, and the ends after the drawer is completed. There must be a little space between the front and the rails or the drawer will not work well—one-sixteenth of an inch, if the work is varnished, usually is not too much space at the top edge between the drawer front and the upper cross rail. This may be reduced one-half at each end of the front.

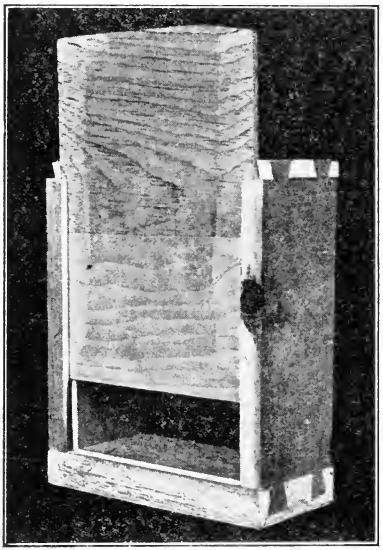


FIG. 41. *Inserting drawer bottom*

The Sides. Next after the front, get out the sides and back end. Glue together the pieces for the bottom so they will be ready when needed.

Make the groove for the bottom in both sides and front and then make the joints for the corners. In making these joints, you must watch the face marks carefully, so that when the parts are all together they will all face properly.

The Bottom. After the sides and ends are together, smooth the bottom and slide it to place by shoving it into the grooves from beneath the back end (Fig. 41). After it is in place, drive a nail up through the back end of the bottom into the back end of the drawer and dress off any extra width of the bottom.

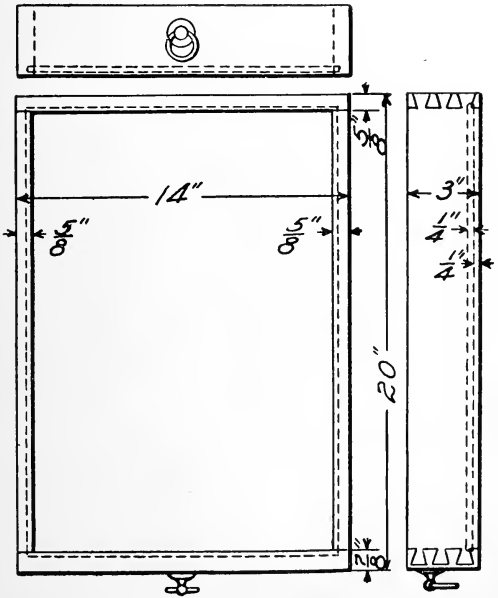


FIG. 42. *Drawer*

Figure 42 gives the usual dimensions of parts for drawers, using a $\frac{7}{8}$-inch thick front. Fig. 41 has short sides and ends in proportion to the thickness of the front, so as to show the joints in the photograph.

SHELVING

Adjustment of Shelves. Before completing the design for any furniture containing shelves, go over the requirements thoroughly in order to be sure that you will have the correct spacing for the shelves, so that when the article is complete you will have secured the greatest possible amount of useful space.

Although shelves can rarely be fitted exactly to the books or to other articles to be placed upon them, yet you may so classify those articles as to economize space by varying the distance between shelves. This will often result not only in finding room for more shelves but also in improving the appearance of the design.

Nearly all bookcases manufactured for sale have some arrangement for adjusting or changing the spacing of the shelves. This provision should not be overlooked in designing such bookcases.

Selection of Material. Another item of much importance is the selection of material for the shelves. This should be of straight-grained stock, and also of some kind of wood that will sustain the required weight. If the wood of which the other parts of the case are made is not suitable for shelves, or is too expensive for such use, the shelves may be made of a different wood and a thin strip of wood, like that of which the case is made, glued to the front

edge of each shelf. In most cases this strip should be considerably thicker than a veneer, so that it can be rounded or worked to some ornamental form to correspond with the moldings about the case.

THE MAKING OF TOPS

Glue Joints. Considerable credit is due to any pupil who can make a good glue joint; and even more credit to one who can properly select and arrange the pieces for gluing. Although the making of a good glue joint is a credit to any pupil, it can be done by any one who understands how to use a plane. It is not so much a matter of skill, as of knowing the correct process. The difficulty in making these joints is, that the pupil does not understand exactly

FIG. 43. *Examining a glue joint with a straight edge*

how to use his plane on ordinary surfaces. For this reason, a glue joint is a very appropriate test for all pupils using planes.

Allowing for Waste. First determine the thickness of the stock which will be required to give the correct thickness after the joints are together and the surface dressed off. Usually $\frac{1}{8}$ inch to $\frac{1}{4}$ inch in thickness is used in truing the surfaces. From boards of the proper thickness, select those having suitable grain. It is not only important that the pieces be of sound stock and well seasoned, but also that the pattern or figure, resulting from the combination of the grain in the various pieces, be pleasing. Sometimes it is necessary to dress the surfaces quite carefully before deciding what pieces to use. The way of the grain on the face surface of each piece must be indicated (Fig. 43), so that after all the pieces are glued together they may all be planed from the same direction.

Quarter Sawing. Another matter of importance is, that table tops and similar parts should have the annual rings at nearly right angles to the surface as shown in Fig. 44. This is secured by selecting the board sawed from across the center of the log (Fig. 45) in common sawing, or by sawing all the log as shown in Fig. 46, which illustrates four ways of quarter-sawing.

FIG. 44. *Arrangement of quarter-sawed boards*

In case no quarter-sawed stock is obtainable, the pieces should be ripped to not more than five inches wide and glued together, as shown in Fig. 47. It will be seen that the pieces have been reversed, so that if the pieces tend to warp, the action of one will counteract that of the other.

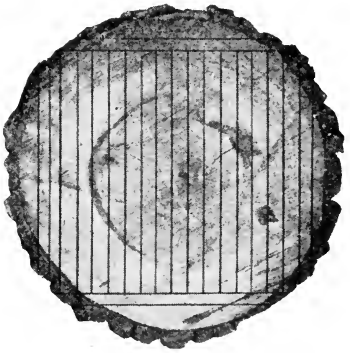


FIG. 45. *Common sawing*

Some kinds of wood will stay in place much better than others, and this should be considered in making up table tops or other wide pieces

Jointing. After the pieces have been properly selected and arranged, and also carefully marked or numbered, so that they will not become disarranged or reversed, the joints must be carefully fitted with the plane. On short joints the jack plane is sufficient, but for joints thirty inches long, or more, the jointer should be used.

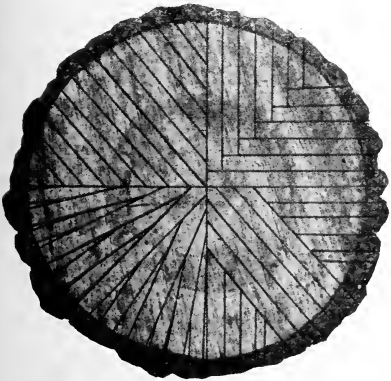


FIG. 46. *Quarter-sawing*

Examine the planes to be sure that they are sharp and not too much rounded, and that they will cut a shaving of good width, but a little thicker at the center than at the edges. The cutting edge should not be absolutely straight, neither should it be much curved.

FIG. 47. *Arrangement of common sawed boards*

Place one piece on edge in the vise and joint the edge carefully. Then lay it aside and joint the edge of the other piece which is to join the edge first jointed. It is not necessary to use a try-square on these edges. They should be at right angles to the surface of the piece, yet it does not matter if they vary a little so long as they make a level joint, and the pieces do not slip sidewise in the clamps. In making a glue joint a skilled mechanic would never think of using a try-square. When you think you have the second edge correct, set the first piece on it and test with a straight edge (Fig. 43), to see if the pieces will make a true surface. Next examine the joint carefully from both sides and ends (Fig. 48). Plane and test the joint in this manner until it gives a true surface and the edges come in perfect contact the entire length. Pressing down upon the corners will help to show defective ends. Also try rapping the under board. There should not be the slightest opening at the extreme ends, even if they are to be cut off in finishing the piece.

Great care must be taken to fit the joint properly. This means that it must be wood to wood at the extreme ends, and no short crooks or other irregularities anywhere in the surfaces. In the center the pieces may be separated enough to allow the thickness of tissue paper between them. Test them carefully, both by the straight edge (Fig. 43), and by looking closely at each end (Fig. 48) and along each side. If necessary, reverse the pieces in the vise in order to see each end and each side. If you are working hard wood, you will often find it necessary to plane all the edges for the joints nearly true and then sharpen the plane before completing the joints. Keep your plane fine set for finishing the edges. Do not think you have a joint until the pieces appear to adhere as you gently pull or push the one upon the other.

FIG. 48. *Examining a glue joint*

Clamping. When you think the joint is correct, place the pieces in the clamps; the manner of applying being indicated in Figs. 49 and 50.

No pressure should be required to bring the

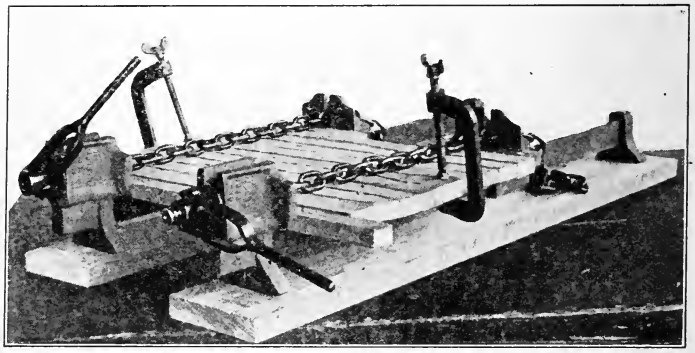


FIG. 49. *Clamping glue joint*

pieces into contact. The clamps are used for expelling the surplus glue, and not for springing or bending pieces into place. The two *C* clamps are to keep the joint from slipping sidewise. Where so many pieces are to be glued, one-half should be glued at a time, making two sections. The picture (Fig. 49) shows the gluing together of the two sections.

In no case put dowels into such a joint. Screw the clamps up a little and examine the joint carefully along each side. If it does not come up tight, or if it tends to bulge, remove the pieces and plane them some more. Do not think the joint is all right if, by using considerable force, the pieces may be

sprung together; for if the joint does not fit perfectly with very little pressure, it will not hold together very long after being removed from the clamps.

Applying the Glue. The application of the glue and the placing of the pieces in the clamps are quite as important as the planing of the surfaces which form the joint. In using cold glue there is opportunity to make a very strong joint if the work is properly done. With the pieces jointed so that the surfaces come into perfect contact, the problem is to get as much glue as possible into the joint without keeping the surfaces the least distance apart. What is wanted is not a film of glue between the two pieces, but links of glue reaching from the pores of the wood on one side of the joint to the pores on the other side. The more glue in this position the stronger the joint; and if the joint is made in this manner and of good glue, it will probably be stronger than the wood.

If a coating of glue is applied and the pieces are at once placed together, most of the glue will be forced from the joint, and the remainder will settle back so far into the wood that very little of the glue will reach from surface to surface. The joint, therefore, will not be very strong and may fall apart.

To avoid this, coat the surface and allow it to dry until the glue has had time to settle back into the grain of the wood. The parts should not be put together until the glue is as nearly dry as it can be, and yet allow the surfaces to be forced together.

This will depend upon the strength of the clamps to be used, and whether the pieces are of a nature to withstand the pressure. Fig. 50 shows how three pieces of hard wood, 2 inches thick by 4 feet long, are clamped. As many more clamps might be used to good advantage on such a table top. Chain clamps (Fig. 253) would have been better than those used.

FIG. 50. *Clamping large glue joint*

The glue for this piece was made thin, and after the first coating had soaked into the wood more glue was applied. After the third coating had dried sufficiently, the pieces were clamped as tightly as the clamps would hold, forcing the pieces together. Some glue was expelled but more was forced back into the wood. The result was a very good joint. If hot glue had been used, the pieces would have been put in the clamps as quickly as possible, and there would have been no need of so many clamps. Hot glue is quite equal to cold glue when properly applied, but it requires too much skill and experience to be used successfully by pupils in their school work.

If you have proper facilities for gluing with hot glue, it will save time and expense to use it when you have many joints to make, but unless you are sufficiently skillful to apply it rapidly and clamp the parts at once, it will not hold properly. You must be as careful to use all kinds of hot glue rapidly as you should be to use cold glue slowly.

Wide Tops. In gluing tops too wide to be dressed in the planer full size, glue them first in halves, and then, after each half has been carefully dressed out of wind and straight, glue the two halves together. (See what is said about "Cross Planing," page 67.)

In getting such pieces out of wind, be very particular to have them exactly correct. In testing the surface both from edge to edge and for wind, use the framing squares or straight edges.

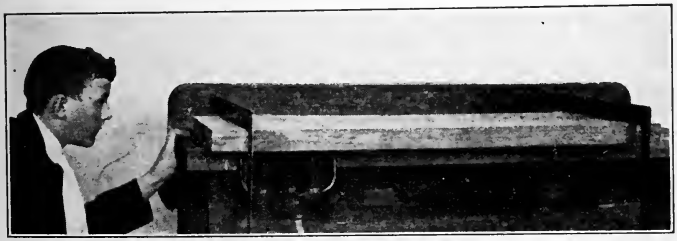


FIG. 51. *Sighting for wind*

In sighting for wind, be very particular to get a position that will insure seeing with exactness. In Fig. 51 is shown how this may be accomplished.

Octagonal Top. Taborets and tables may sometimes have octagonal or hexagonal tops.

The octagonal top is made in the same manner as a square top, except that, after both surfaces are finished and both ends and edges squared, the corners are cut off, making the octagonal shape. To lay out the octagon, draw the diagonals as shown in Fig. 52, and then the arc *H-E*. This gives the point *E*, at which the corner is cut. Set the gauge to this point—the space *D-E*—and from each corner draw a gauge line across the edge of each side (*L-L*). These gauge lines should be pencil lines. Draw knife lines on both top and bottom surfaces connecting these lines.

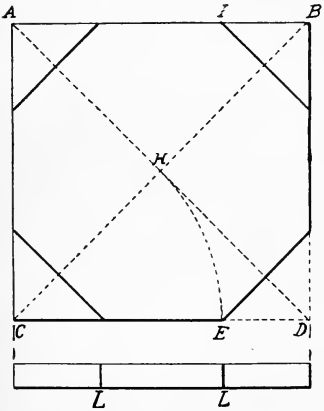


FIG. 52. *Laying out an octagon*

Saw off the corners and plane to the lines. Usually octagonal tops should be chamfered. This is done in the same manner as the chamfering on the bench-hook in "Elementary Woodwork." Be sure to use pencil lines for such chamfering, and be careful also to work exactly to the lines.

Hexagonal Top. Before attempting to make a hexagonal top, draft out the top and locate on the

draft the legs and rails, if there are to be any rails, beneath the top. You will notice that the top appears to be much smaller than a square top having the same length of sides as the long diameter of the hexagon.

Lay out the hexagon by drawing a circle on the top surface (Fig. 96), and then use the radius to determine the sides. Draw knife lines connecting these six points. Saw near the lines and finish with a plane similar to planing an end.

PLANING

Cross Planing. In making pieces for furniture, you are frequently obliged to reduce to a level surface a wide board, a table top, or a similar piece. To accomplish this in the quickest and best manner, you may place the piece crosswise of the bench and plane across the grain. The plane is usually run at an angle, as shown in Fig. 53, but sometimes it is run straight and directly across the grain. By carefully watching the effects of the cutting, you can determine how best to use the plane. As a general rule, after cross planing over the surface, you will need to plane over the surface in the ordinary manner. In all this planing be very systematic. Watch carefully where the plane cuts and do not set the plane to cut down into hollows.

Examine the piece often in each of the three ways

you learned in the first lessons in "Elementary Woodwork." If you are not certain about these tests review those lessons, for the success of your work depends very much upon your being able to

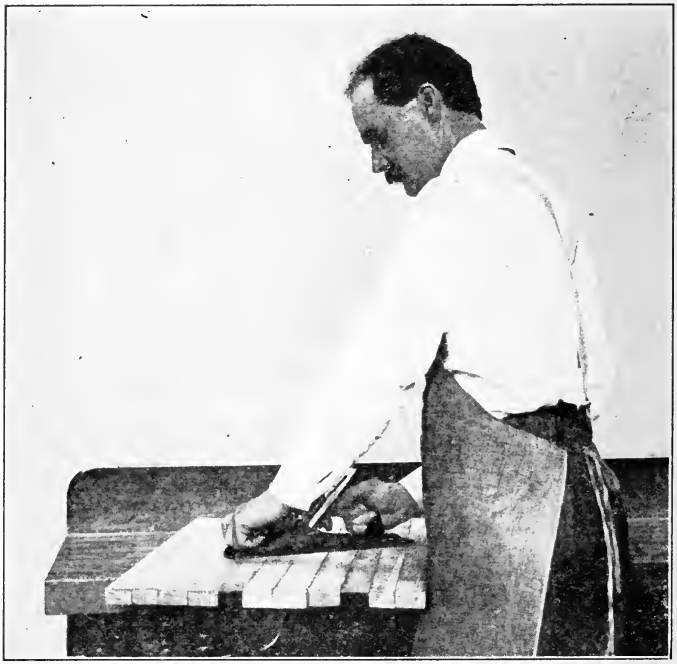


FIG. 53. *Cross planing*

make the surfaces of your pieces true in every respect.

If the piece is crossgrained and does not plane smooth, you may leave the rough places a little high, so that after you have finished them with a scraper

they will be level with the other parts of the surface. Of course in many cases, your only way will be to dress the surface true, and then dress it all down with the scraper or scraper plane.

Sprung Pieces. Sometimes pieces will be sprung their entire length and require a great deal of planing to make them straight. Often this cannot be done without making them too thin. In such a case dress the pieces to an even curve and a smooth and even thickness, and depend upon the other parts to hold them straight after they are in place. If this does not hold them, they should be discarded. Do not spoil a fine piece of work by using a crooked piece of stock; yet do not needlessly waste a piece which will be all right when properly placed.

VENEERING

Veneering End Grain. In making such pieces as the large armchairs (Figs. 149 and 155); taboret (Fig. 90); table (Fig. 188); and the piano bench (Fig. 191), which are to be finely finished or polished, the visible end grain may be covered by veneering. Although the veneering of entire pieces is too difficult an operation for beginners, the covering of such end grain as the end of a table top, the ends of chair arms, and of other similar places, may be successfully accomplished by any one who can use a plane, and follow simple directions.

Preparing the Surface. The first step in covering the ends of a chair arm or table top is to make the piece of the required length, and the surface to be covered a true plane. It is not sufficient that the end be planed *nearly* true, and rubbed smooth with sandpaper. It must be *entirely* true out to the extreme ends and edges, and this can be accomplished only with a plane.

Sizing. After the surface has been trued, cover it with cold glue. The glue will soon soak into the end of the piece, and more glue must be applied. Continue applying glue until there is a coating of dry glue left upon the surface. Let this dry until it is so hard that it can be scraped smooth with a cabinet scraper. While the glue is drying, prepare some thin pieces of wood for the veneer. If you have regular veneer at hand, it may be used. If you have no veneer, take a scrap of wood the proper size, like the piece to be covered, and plane it smooth on one side. If it is more than $\frac{3}{16}$ inch thick, draw a gauge line around it and rip a piece off about $\frac{1}{8}$ inch thick. If it were scarcely $\frac{1}{16}$ inch thick, it would be thick enough for veneering; but as you are not accustomed to using veneers, you might split or break it. Therefore, you had better use a piece about one-eighth of an inch thick.

Gluing. Scrape the dry glue on the end until it is removed down to the wood. Place more glue on both the end and the veneer in the ordinary manner, and

when the glue is quite sticky clamp the veneer to place. Use a smooth block against the veneer. Be sure to have the outside of the veneer reasonably smooth, so that the clamp will press evenly. Use plenty of clamps, and be very careful about forcing the veneer tight around the edges.

After the glue is thoroughly dry, dress the veneer to about $\frac{1}{32}$ inch thick, and round it a very little at the edges to make the edge of the veneer invisible. If your work has been done properly, the end can be finished the same as a surface.

Veneers are usually laid so that the shrinkage of the wood will not affect them. This makes it necessary for the grain to run the narrow way, or at right angles to the wide surfaces on table tops, chair arms, and other similar objects.

BACKING

Three Kinds of Backing. A great deal depends upon the proper backing being used in such pieces as bookcases, music cabinets, and in all other pieces where the back helps to strengthen the frame.

In elementary cabinetwork we have to deal with three classes of backings: those consisting of a single board, either of one natural or of several pieces glued edge to edge; those joined by loose tongue and groove joints; and those formed of one or more panels, having both stiles and rails

Backs consisting of a single piece are most often used, both because they are simple and because they are more apt to keep the framework square than are the other styles unless they are very carefully made.

Solid Backs. Solid backs must not be used when their size would be such that the ordinary shrinking or swelling of the lumber would cause a disturbance of the framework, or make the back split or warp. The efficiency of such backings may be greatly increased by a careful selection of wood, and by filling the pores with such a filler or finish as will reduce the shrinking or warping to a minimum.

Although many defects which would not be permitted in a table top, may be allowed in the backing, yet such features as the way of the grain, etc., which have to do with the stability of the lumber, should be quite as carefully considered as in selecting pieces for a top.

If the back contains glue joints, they should be made quite as carefully as for any other part.

The thickness of the material is a matter too often disregarded. A fine bookcase may be rendered quite unsatisfactory because the back, though well joined and fitted, is so thin that its springing allows doors, and in fact the entire case, to appear rickety.

Fastening Backs. One of the most important, though seemingly immaterial, points of the work is the place and manner of fastening the back in position. Of course, if it is a very small piece,

it is not of much consequence how it is fastened so long as it is made secure; but when shrinkage and movement have to be considered, not only the place for the fastenings but whether they should be screws or nails, also is of much importance.

If the back is wide, like the back of Fig. 215, it should be fastened near the center with screws at both top and bottom. If the back is of matched boards, a sufficient number to make a piece 18 inches wide should be glued and placed at the center, and at least four screws used in each top and bottom end. The remaining pieces should have a screw to every 6 inches of width, and if there are two screws in each end of each piece there will be much less danger of the case racking.

If the back is a solid piece the central portion should be secured the same as above, and at each side of this the holes through which the screws pass should be considerably wider than the shanks of the screws. This will allow for the shrinking and swelling of the back.

Another way is to use screws at the sides so slim that they will bend before splitting the board. While a $1\frac{1}{2}$-to 2-inch No. 10 screw may be used in the center, No. 8 screws may be used at the sides.

Imitation Paneling. A modification of the matched backing is the use of thick and thin pieces alternating, which gives an appearance of paneling. Such an arrangement is often desirable and adds

nothing to the labor, if the thin lumber is at hand and of a thickness to fit the groove made by the match plane. In order to have the thin parts fit to the bearing, the same as the thicker pieces, the thick pieces are cut down flush with the others at both top and bottom (Fig. 54).

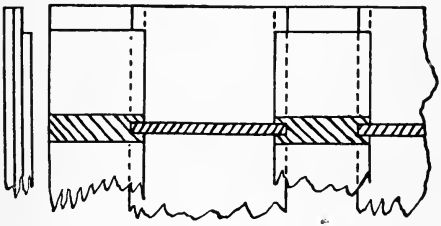


FIG. 54. *End of false paneling*

If the backing is to be a complete panel, the joints of the framework should be well fitted and glued, and the complete panel thoroughly secured. No allowance need be made for shrinking or warping and each screw should be firmly set.

Nails should not be used in fastening backs to place, except in the very smallest or cheapest work, because the tendency of the case to rack is certain to work the nails loose.

PATCHING AND PLUGGING

Method of Patching. Sometimes, rather than discard a whole piece of wood because of a small defect, the defective spot may be removed and the hole filled with a plug or patch of suitable wood.

If the grain of the wood is not strongly marked, the patch may not be visible after the job is com-

pleted. If there are strong contrasts in the grain—such as in quarter-sawed oak—the inserted piece may show very plainly.

The method to follow in cutting out and inserting these pieces is substantially the same, whatever the nature of the wood. The opportunity for the exercise of skill and judgment is in the selection of the material and in determining the shape and size of the hole to be cut out. Usually, the hole should be of a rectangular shape and as small as will include the defect.

The piece to be inserted should be as nearly as possible like the wood that will enclose it, not only in texture and in color but also in width of hard and soft grain, and should be so trimmed in fitting as to bring similar grains together.

FIG. 55. *Piece to be patched*

While the first step is to determine the size of the part to be removed, the shaping of the piece to be inserted is the second step, except when the hole is to be made by boring with a bit.

In patching such a defect as that shown in Fig. 55, a square piece may be inserted, or a bit may be used to bore out a smooth round hole, and the patch fitted into it. Which is the better method to be used must be determined by circumstances. In this case a rectangular piece is to be used. It

should be a little larger than the worm hole so that all defective wood can be cut out.

The Taper. The sides of the piece should be slightly tapered, as shown in Fig. 56. It is of much importance that the four surfaces should have exactly the same amount of taper. If they do not, the piece will not be equally tight at all sides when driven into place. If the slant is too great, the edges against which the patch impinges will be crushed or bent, and will show a black line when finished. This will also be the case if the patch is driven in too tight. After smoothing the small piece on its four sides, lay it on the part to be removed and draw fine, but distinct, knife lines around it (Fig. 56). Be careful to have the lines all of the same heft. Remove the piece and cut out the opening, being careful not to bruise the knife lines. Should the amount of waste material to be removed be large, part of the work may be done by boring. Be sure to cut the hole deep enough. Slant the sides nearly as much, but no more, than the sides of the piece to be inserted (Fig. 57).

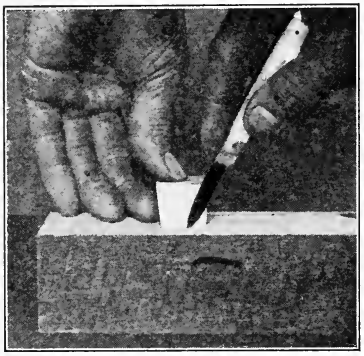


FIG. 56. *Scribing around patch*

Test the work by placing the piece in the hole, examining to see if it is tight, and also to make sure that the grains will properly meet when it is driven to place. No attempt need be made to drive it in flush unless this is necessary to bring the grains in proper relation. The patch shown in the cut is thicker than is usually used. This extra thickness is to show the shape and taper of the sides more plainly in the photograph.

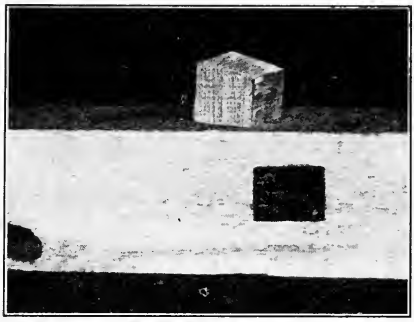


FIG. 57. *Hole cut for patch*

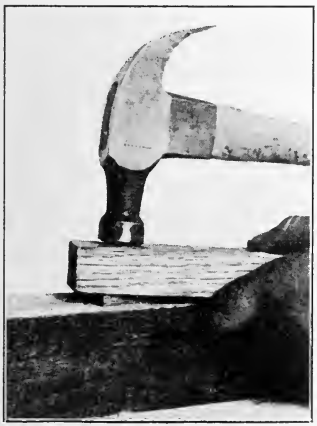


FIG. 58. *Driving patch*

If all appears to be right, place glue on the piece and in the hole. Sometimes it is better to size the end grain. When the glue is ready, drive the piece to place by using a block and hammer, as is shown in Fig. 58. If you do not use the block, the wood in the patch may be crushed or bruised so that after it is dressed smooth

it will show crushed grain. After the patch is in place, it should appear as shown in Fig. 59.

Be sure and allow the glue to become thoroughly dry, and then dress off the patch flush with the adjoining surface.

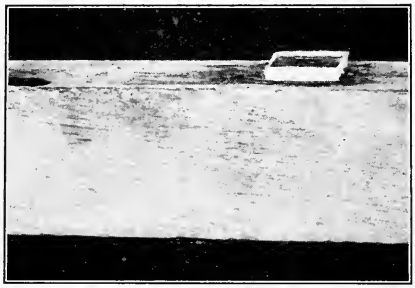


FIG. 59. *Patch in place*

If the hole is to be bored, the operation is much the same, with this exception, that in this case the bit determines the exact size of the hole, and the piece is shaped by drawing a circle on it and chiseling carefully to the circle, allowing the taper as in the other method, but usually not quite so much.

Plugging. Screws and nails are sometimes set far enough below the surface to allow of their being covered with wood. This is accomplished in the same manner as the patching of defective spots, and is called plugging.

When many plugs of a kind are required for a piece of work, they may be purchased from dealers, or they may be cut by using a special bit or cutter designed for this purpose. This makes the operation quite easy. If plugs are to be used, then the places for them should be made before boring the hole for the screw or driving the nails.

SMOOTHING

When to Smooth the Surface. It is a waste of time to smooth each piece or surface as it is worked to size, for, before the parts are fastened together, there are many chances for the surfaces to become dirty or bruised. After the joints have been tested by clamping, and before the glue is applied, is the proper time for smoothing the surfaces ready for the varnish or other finishing material.

If the article is small or if the parts are likely to become stained or bruised in the clamping, smooth only such pieces or surfaces as cannot be easily smoothed after the gluing. In gluing together the parts of a chair, the sides of the legs containing the mortises and all sides of the rails must be smoothed before the tenons are in place.

If the parts join so that one or more surfaces can be planed after the joint is together, these surfaces should be left until after gluing. This applies to such articles as frames (Fig. 226), the backs of some armchairs, and like pieces. By not finishing such surfaces before gluing, an opportunity is left to dress the two surfaces flush, thereby making a proper finish.

Planing. To do the smoothing, first plane the surface, guarding against tearing crossgrained portions, splitting ends, or bruising dressed surfaces against a bench stop. Sometimes, but not generally, the different parts of the surface may be planed

from different directions. Sometimes the plane will cut smoother if held at an angle of forty-five degrees. Plan to go over the pieces, reducing them to nearly a finished surface; then sharpen the plane and go carefully over them again. This time be very careful to plane in the same direction as you did the first time. The common mistake in planing is the tendency to use the plane with too heavy set. The plane must cut a very fine shaving, and you must go over each surface in a systematic manner. Begin at one side and take a shaving, as indicated by the arrow at *A-B*, Fig. 60. Next take a shaving at *C-D*, then *E-F*, and *G-H*, etc., always in the regular order, even if the plane does not cut the entire length of the piece. You worked the surface straight and out of wind before making the joints, and now you are simply to smooth the minute unevenness. Unless you are very careful to proceed systematically, you will plane the piece in wind, or crooked, and spoil the work. If you did the planing properly in jointing the piece, going over it a few times with the plane should make the surface as smooth as a plane can make it. This does not mean that it will be sufficiently smooth, for the planing is very seldom sufficient.

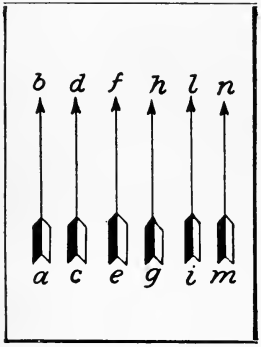


FIG. 60. *Method of planing*

Scraping. The next step is to scrape out all roughness left by the plane. To do this, use a cabinet scraper about two inches by three inches for pieces of small size, such as the parts of chairs and stools. Where the surface is quite smooth and the grain even, there will be little difficulty in using the scraper. In scraping quarter-sawed oak or coarse-grained or knotty surfaces, it is necessary to examine the surface continually and to change the direction of the scraper frequently in order to avoid making the piece worse instead of better. You must hold the scraper so that it will be supported by the hard grain, otherwise the soft grain will be removed and the surface made so uneven that nothing short of replaning will smooth it again. If the scraper chatters, turn it to a different angle. Often it is necessary to change the scraper at every stroke from the position in Fig. 61 to that shown in Fig. 62.

FIG. 61. *Using a scraper*

Always hold a scraper firmly and so that it will cut at the center; otherwise the corners will be lowered, the joints will not fit, and, worst of all, the appearance of the piece will tell a practical workman

that it was made by some one who either did not know how, or did not care, to do good work.

Lastly, and most important of all, do not use the scraper after it has become so dull that it will not easily remove a real shaving.

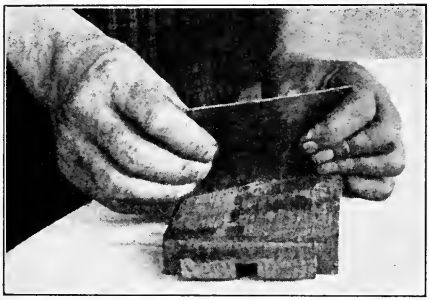


FIG. 62. *Using a scraper*

Continue the scraping until there is not a single spot of broken grain or roughness of any sort on any surface that will be visible after the finish has been applied. Do not smooth the surfaces that are out of sight. If there is a small spot that requires considerable scraping, do not scrape a deep hole at this place but scrape around it for a sufficient distance to make the whole surface appear level. You will often find it necessary to scrape both with the grain and against the grain. Frequently, you will need to scrape at an angle of about forty-five degrees across the grain; and sometimes a little careful scraping directly across the grain is useful.

When much scraping is required, it is necessary to hold the pieces securely. Most of the pieces can be held in the vise. Some are best held by using a clamp, either by clamping them to the bench or by

placing the clamp against the end opposite the stop, as shown in Fig. 63. So seldom is there any use for a tail vise that one should not be on the bench, for if one is at hand, it will be used many times when it will do harm rather than good. One learns far more without it.

FIG. 63. *Clamp at end of piece*

Sandpapering. After scraping comes sandpapering. This does not differ essentially from the sandpapering of small pieces in joinery. If the surfaces have been well smoothed with plane and scraper, No. 1 paper is coarse enough. Sometimes No. 1½ is used. Continue with finer grades until the surface is sufficiently smooth. Remember you cannot do nice varnishing over a rough surface, and the smoother the surface the better the varnish or other finish will appear. Be very careful not to round the corners or the edges at the joints. For nearly all of the small pieces no sandpaper block should be used; but for some of the larger surfaces a block is better than the hand or fingers. Be quite as careful not to sandpaper too much as to sandpaper enough.

Removing Glue. After the parts have been glued together, all surplus glue should be removed, because, if any remains, it will injure the finish. A chisel is the best tool to use in removing glue from around the joints. The scraper usually

tears the grain near the joints and gives them the appearance of having been poorly made, but for thin spots of glue away from the joints, it can be used better than the chisel. Do not attempt to sandpaper over glue, or to remove glue by sandpapering.

CLAMPING

Use of Clamps. Some information in regard to clamping will be found in the directions for making the different articles. General directions only will be given in this place.

Select the clamps with care. To do good work you must have at hand a variety of clamps, and use each in its proper place. Nearly all clamps will injure the wood unless blocks of wood are placed between the faces of the clamp jaws and the finished surfaces. Blocks for this purpose should be kept at the gluing bench. If the work is of a nature that will permit of it, the clamp should be laid carefully in position on a bench and the pieces laid into the clamps. This is the method followed in the work illustrated in Figs. 66 and 70. The pieces were then placed in a vertical position for the purpose of photographing them. The chair (Fig. 75) was clamped by laying three clamps on the bench, and then placing the chair upon these clamps. The last three clamps were then laid upon the chair. After the clamps had been tightened, the chair was set as shown in order to look for wind, etc., and the diagonal clamp applied.

Do not attempt to drive joints together after they have been covered with cold glue. This glue, if allowed to become sufficiently dry to make a good joint, will resist all efforts at hammering, but will yield to the steady pressure of a good clamp.

Adjusting Pressure. One of the important points to keep in mind is that the pressure must be opposite to the resistance. The pressure applied with an ordinary clamp is such that if it is not at the proper

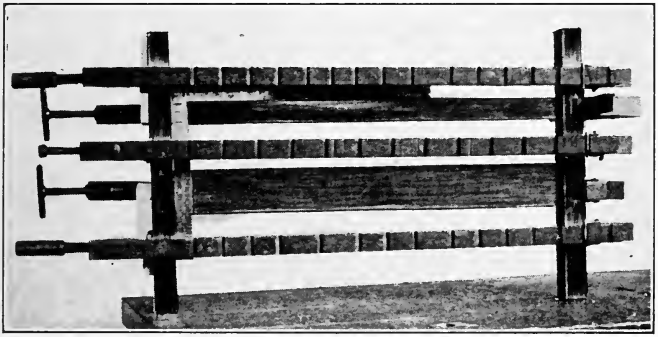


FIG. 64. *Clamping*

point, it will spring the pieces out of place. This applies to the vertical as well as to the horizontal adjustment.

Some clamps are so made that the pressure at the end of the screw is so far away from the bar, that it is necessary to block the work away from the bar in order to bring the pressure at the center of the edge of a $\frac{7}{8}$-inch piece. Others will clamp 2-inch pieces only by placing a clamp on each side, as in Fig. 64.

Sometimes the blocks can be adjusted to bring the pressure at the center. In Fig. 65 a clamp is shown with the block raised to cause the clamp to press against the center of the piece. Fig. 66 affords an unusually good typical illustration of clamping, showing blocks to protect the edges and clamps opposite the main corner joints.

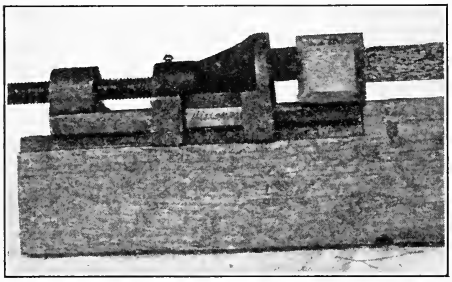


FIG. 65. *Clamping*

In clamping this chair back, the rails were first laid on two clamps and the vertical pieces forced nearly to place; the two clamps for the ends were then laid on the bench and the stiles laid in place. The rails and slats were then removed from the temporary clamps and placed in position, and the corner joints closed. After this, the three long clamps were placed in position and tightened. Lastly, the corners received a final tightening. The whole arrangement was placed vertically to secure a photograph.

Three clamps suffice for the four center pieces because they are so close together that there is little danger of springing the cross rails. Usually, there should be a clamp opposite each tenon. Notice also the framing square in position to test the corner.

Tightening Clamps. In applying several clamps it is very essential that they be tightened gradually, turning each a little in succession. Stop often to see that they are drawing the parts square and out of wind. Notice that only a small part of the

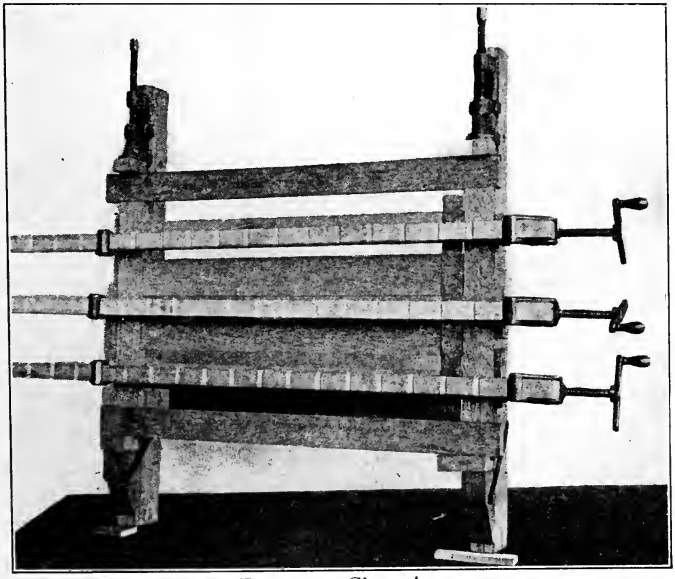


FIG. 66. *Clamping*

screws have been turned through the nuts. Always plan to keep the movable jaw as near to the end as you can. It is often necessary to turn the screw back and to move the other jaw up a notch after the tenons have been forced into the mortises.

Squaring with Clamps. Examine carefully all the illustrations of clamping, and especially Figs. 65, 66, 67, 69, 72, 75, and 76, before using any clamps. In some of these you will notice clamps placed crosswise, and others at various angles. This is to force the pieces square. The clamps may be made to bring joints square, even though the working has thrown them very much out of true. Know that there is a way if the pieces are properly fitted, and

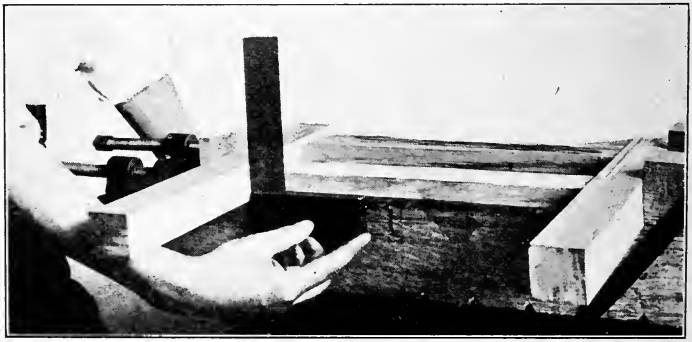


FIG. 67. *Testing with try-square*

keep trying until the clamps draw the pieces into proper shape. If the lines are properly drawn and the joints carefully worked, there should be little difficulty about the joints drawing up square.

Preliminary Clamping. Always clamp the work together before applying any glue. Clamp it section by section first and, after the sections have been glued and are thoroughly dried, clamp the sec-

tions together. Test the work in many ways, both in the preliminary clamping and after applying the

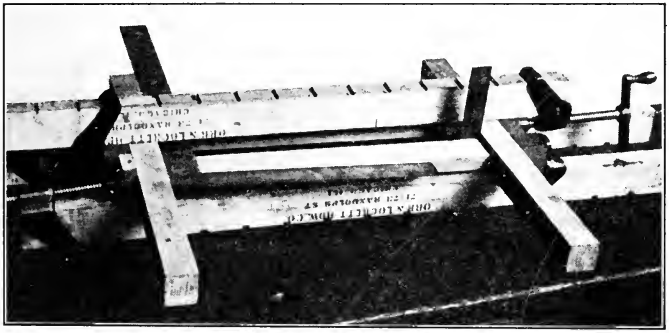


FIG. 68. *Testing with framing-square*

glue. Apply the try-square to every joint, as shown in Fig. 67. Apply the large steel square wherever practicable as shown in Fig. 68. Look for wind from

FIG. 69. *Looking for wind.* (*See* FIG. 184.)

all sides in every piece (Figs. 69 and 70). If the piece is irregular or the face surfaces obscured, lay straight edges or the blades of framing squares on the piece to assist in testing for wind. Always test from the face edges or face sides.

To determine whether a frame is square, measure with a stick or rule between opposite corners and test it

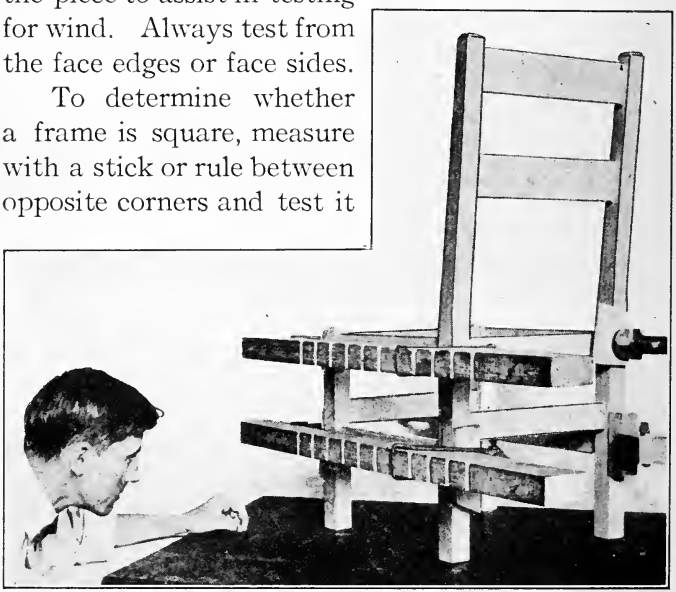


FIG. 70. *Looking for wind.* (*See* FIG. 184.)

with the try-square and framing-square. Be particular about having the parts rest firmly on the bench so that they will not spring out of place while left to dry. A few wedges or blocks beneath the clamps will sometimes save a great deal of twisting and springing. Do not attempt to true your work by an uneven bench top or by the floor.

In Fig. 71 is shown the most simple form of clamping. Fig. 72 shows how clamps are placed to

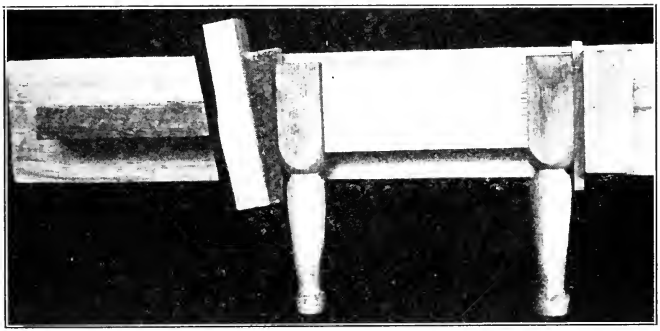


FIG. 71. *Clamp on footstool legs*

pull two pieces parallel. In this case, the top end of the wider leg is being drawn in, and this without pulling any harder on the other leg.

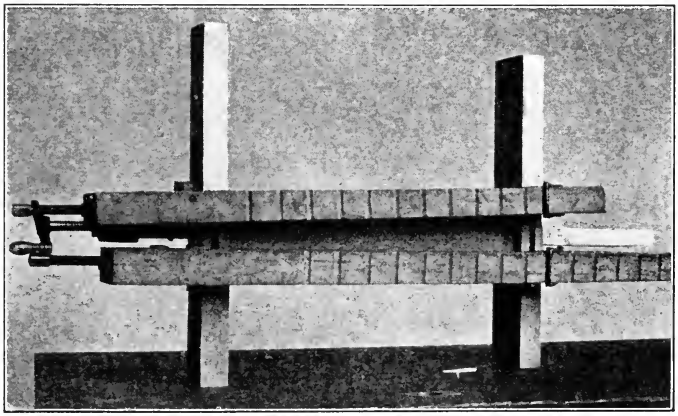


FIG. 72. *Clamp on chair legs*

Fig. 73 shows how the arms of large chairs are kept square. The piece across the end of the arm

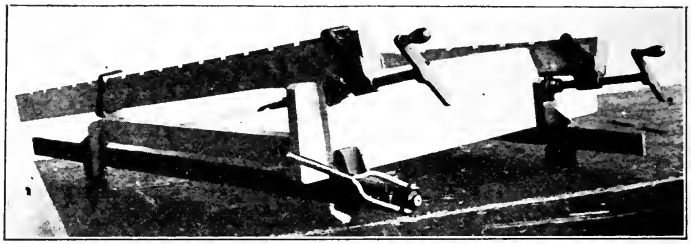


FIG. 73. *Clamping arm of large chair*

is not only to keep the clamps from jamming the surface, but also to keep them from splitting the arm. In such places, one block or strip should be used

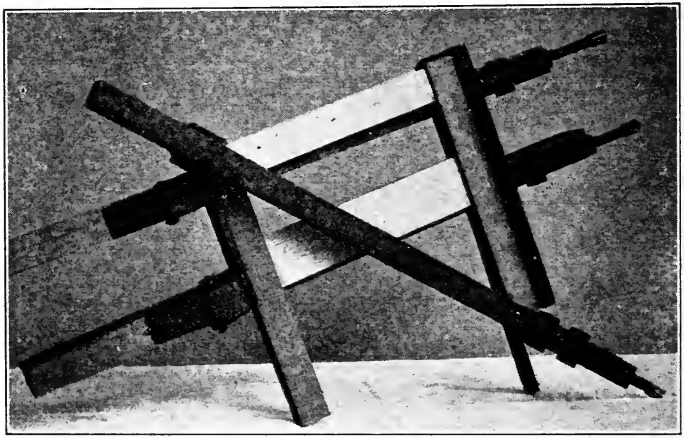


FIG. 74. *Diagonal clamp*

for both clamp jaws instead of a block under each jaw. Fig. 112 shows a similar case.

Diagonal Clamps. Fig. 74 illustrates the use of diagonal clamps. The same result often may be obtained by placing the clamps at an angle, as shown on the side in Fig. 75. This draws the seat out of wind. There is also a diagonal clamp extend-

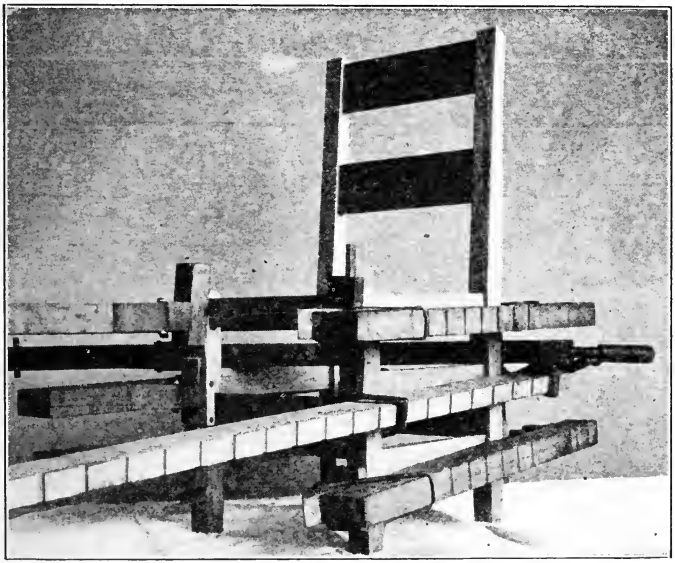


FIG. 75. *Clamp at an angle*

ing from the back leg to the opposite front leg on this chair. This is to draw the seat square.

In using clamps at an angle or diagonally across the frame, a great deal of judgment must be used in tightening them. It is essential they be tightened just enough; but also, that the tension be so dis-

tributed that the frame will not change shape after the clamping is completed. In using cold glue, which does not set quickly, if the clamps on one side are all at an angle, there is danger of the piece changing form so slowly that the movement will not be noticed, but on examining it after the glue has dried it will be found very much out of shape.

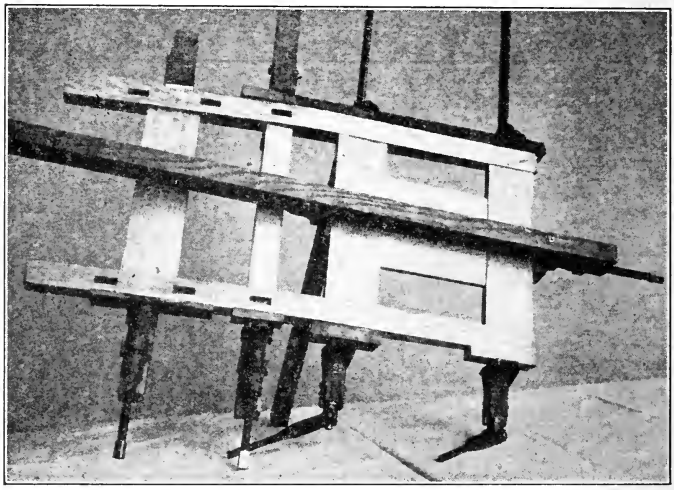


FIG. 76. *Clamping in two directions*

When clamps are used at an angle the only safe way is to examine the work occasionally as the glue is drying.

In Fig. 76 is shown how the clamps must be applied where the joints are in two directions. The same method is used in clamping the back of hall

seat (Fig. 162). If there is any difficulty about drawing the piece square, two clamps may be used instead of one and both or either of the clamps placed at an angle (Fig. 164).

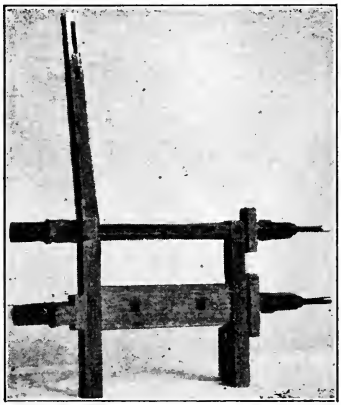


FIG. 77. *Gluing side of chair*

Clamping Sections. After two sides of a piece have been glued, care must be taken not to break these joints in clamping the other parts. If the clamps are so placed that they do not press squarely against the sides and opposite to the resistance, the tendency of the strain is to twist the piece and break the joint. This twisting may be so slight as to be scarcely noticeable and yet break the joint. Usually, the front rails and legs are glued together (Figs. 67 and 74), then the back rails and legs (Figs. 69 and 76), and lastly, the side rails are glued to place, completing the chair (Figs. 70 and 75). In chairs similar to Figs. 140 and 144, the sides are glued first (Fig. 77), and then the front and back rails secured. The sides are glued first in chairs similar to Figs. 149 and 155, in order to clamp (Figs. 68 and 72) the arms to place more conveniently. In Fig. 73 is shown the clamping of an arm.

FASTENING TOPS TO FRAMES

Corner Irons. A good top may be ruined by improper fastening to the frame. There are several ways of making the top secure, and yet of leaving it so that in case it either shrinks or swells, it will neither open at the joints nor separate the framework.

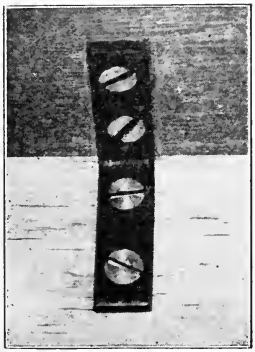


FIG. 78. *Corner iron in use*

A very easy way of securing the top is by using small corner irons (Fig. 78). These are sold by dealers, and are easily applied. One screw in the top and one in the rail are usually sufficient for each corner iron. The number of corner irons may vary according to the size and character of the top. For an ordinary top, 2 feet by 3 feet, one corner iron at the center of each end and each side, and one on the side rail close to each corner should be sufficient. The location of the fastenings should in most cases be in this systematic arrangement. The peculiarities of grain and other special features resulting from the variations in the material may make necessary a different number of fastenings.

FIG. 79. *Button holding top*

Always avoid inserting a screw in a glue joint or so near to the joint that it will tend to open it. If the top is made of many pieces it should be placed bottom side up on the bench; the frame placed upon it, and the places for the fastenings carefully selected and marked. They should be placed so that the top may either shrink or swell without straining them.

FIG. 80. *Boring for screws*

Buttons. A better method of securing the top is to use buttons, as shown in Fig. 79. The groove in the rail to receive the end of the button should be short as shown, and not the entire length of the rail as is sometimes made to save expense in machine-made work. The buttons should be similar in number and location to the corner irons, as the screw fastenings should be also (Figs. 81 and 82). The holes in the rails for screws should be considerably larger than the shanks of the screws to allow of movement as the top changes in width. For the same reason the end or shoulder of the button (Fig. 79) should not be tight against the side rail. To make the holes for the

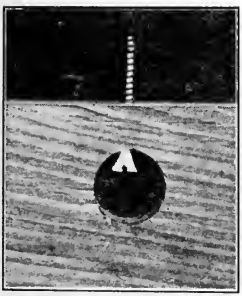


FIG. 81. *Screw holding top*

screws, first bore through from the top of the rail (Fig. 80). After this hole has been bored, another may be bored (Fig. 81), or a place for the head of the screw may be cut with a gouge (Fig. 82.) This is probably the best form of fastening, considering the ease with which it is made. If we do not consider the work of applying it, the button is undoubtedly best.

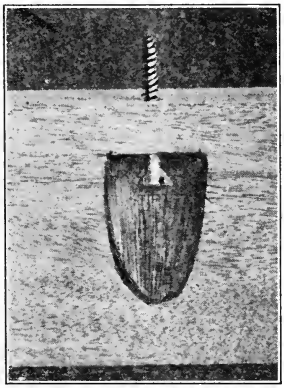


FIG. 82. *Place for screw-head, cut with gouge*

Boring Holes. Boring holes straight up through the rails, even though the rails may be narrow, is not advisable if either of the other methods can be used. This method marks the work as that of a novice, and should be avoided.

PART II

Type Forms of Cabinetwork

BOOK RACKS AND TABORETS

Book Rack Corners. This rack (Fig. 83), is a rack made of soft pine. It will look well made of any wood. In getting out the stock, work the two ends

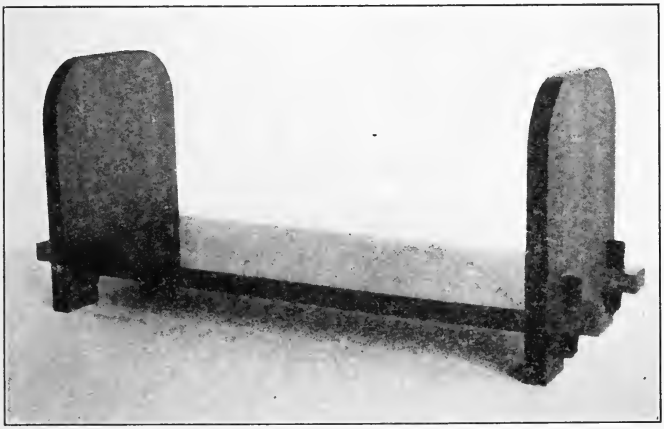


Fig. 83. *Book rack*

in one piece until the upper corners have been rounded. Dress both surfaces and edges. Round the corners of the end piece and square the ends of the shelf before laying out the mortises and tenons.

In striking the circles for the corners, place a thin block under the stationary leg of the compasses (Fig. 84). The corners should be smoothed with the chisel, using a shearing cut (Fig. 85). Before chiseling the corners they may be rounded by sawing with a compass saw (Fig. 97). Usually, the best way is to saw off most of the waste material by using the backsaw, sawing first as shown at *A*, Fig. 86, and then as at *B*.

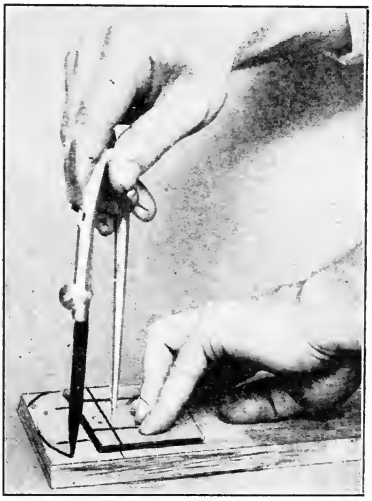


FIG. 84. *Marking the round corners*

Laying Out. To lay out the mortises and tenons on the shelf and ends, first draw light pencil lines across the grain, then draw the gauge lines, being careful not to make any lines beyond the pencil lines. Draw pencil and gauge lines on both top and bottom sides. Set the gauge to the line nearest the face edge, and draw all the lines at this distance from the edge for both mortises and tenons. Continue setting the gauge for each space from the face edge until all the lines are drawn. Do not forget to draw all of the lines for the holes in the tenons

for the tapering wedges. See drawing (Fig. 87). Remember that these holes are not of the same size on both the upper and lower sides of the shelf.

FIG. 85. *Rounding corners*

Before cutting the piece in two, lay out the openings for the bottom ends and bore the holes at the corners; also bore the holes for the mortises (Fig. 86). After working all the mortises, cut the piece in two and square the ends with a plane. Saw from the ends into the holes, using a ripsaw. The part between the holes may be cut out either with a compass saw or with a chisel. If you use a chisel, cut first a little away from the line, cutting out a *V*-shaped space on both sides, as in working a dovetail. Continue cutting in this manner until the piece breaks away, and then finish with the chisel, using the shearing cut as in truing ends or making joints.

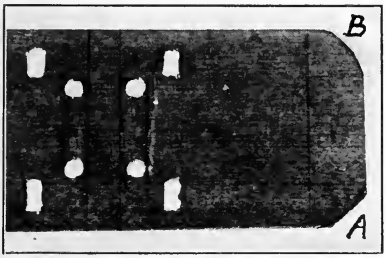


FIG. 86. *Sawing corners*

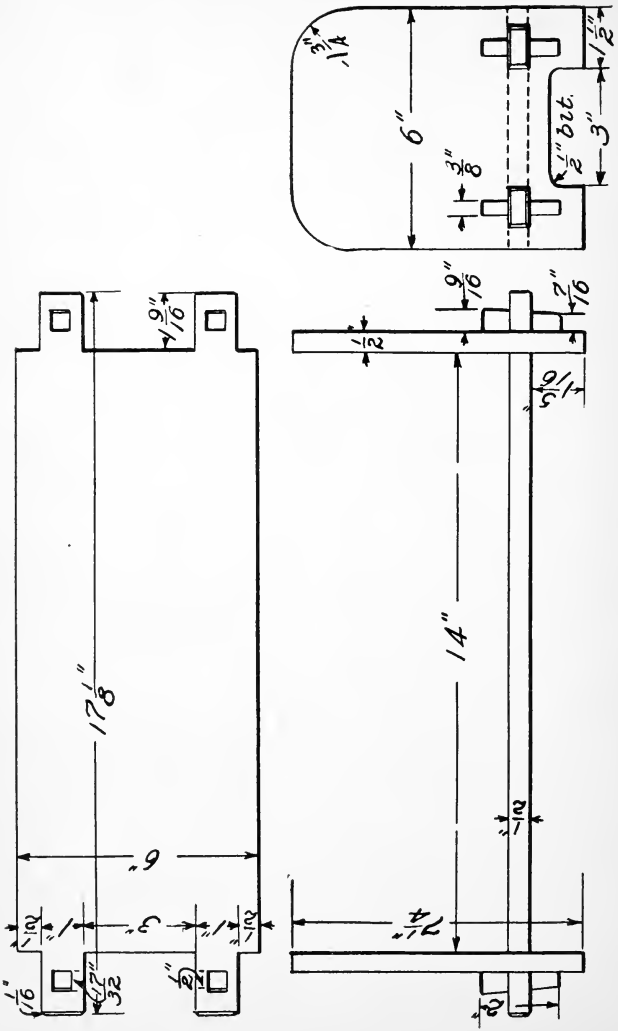


FIG. 87. *Book rack*

If you have been careful to draw your lines correctly, and in the order directed, and to work to them, the pieces will go together nicely.

Wedges. Your next task is to make the wedges. There are three ways of doing this: First, dress a piece to the size of the larger end of the wedge, and after cutting it into the correct lengths for the wedges, taper it. To get the taper, set the gauge to the size of the small end and draw a line across one end of each piece. Plane down to this gauge line. Second, make a piece equal in length to the wedges, and also equal in thickness. Lay out the wedges on its surface (Fig. 88), and then rip them apart, finishing with the plane. Third, if you happen to have a piece just thick enough for the wedge at the widest end, you may taper the whole piece (Fig. 89), and then rip the wedges apart, finishing the straight sides last. In chamfering the ends, be careful not to

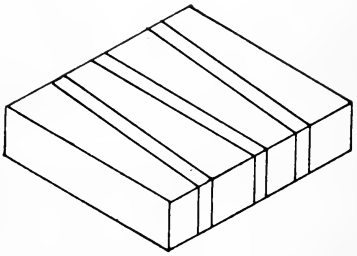


FIG. 88. *Piece for wedges*

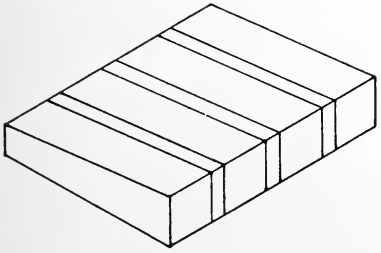


FIG. 89. *Piece for wedges*

make the chamfers too large. As this piece has no corners which are difficult to polish, it may be given a rubbed varnish finish, or it may be finished with several coats of shellac.

Taboret. In Fig. 90 is given a very good design for a first attempt at making glue joints, smoothing surfaces, and polishing. The general directions cover substantially every step in the construction.

FIG. 90. *Taboret*

Make all the parts and fasten them all in place, then separate them and do all the finishing. After the last rubbing of the finish, fasten all the parts together again.

This feature of having the parts separate while polishing makes it possible to do very fine finishing, and therefore you should not be content with any finish on this piece except a first-class polished varnish.

The sizes of the various parts may vary considerably. This design, with feet a little larger in proportion, may be made 29 inches high and 24 inches square, thus making a fine parlor table. It may be made in any of the popular oak finishes, or it can be made in mahogany and polished.

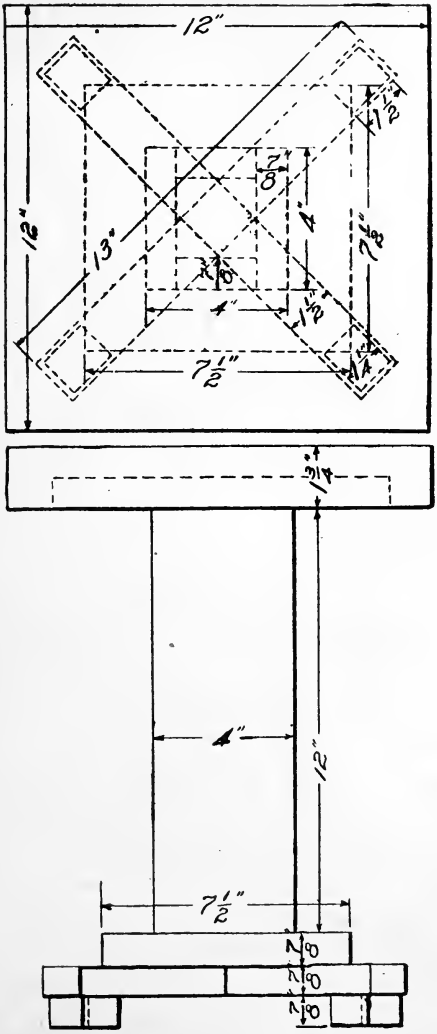


FIG. 91. *Taboret*

Tops. Tops for such tables need not necessarily be made of 2-inch thick material, but rather of 1-inch and a border of similar material glued around the edge as shown in Fig. 92.

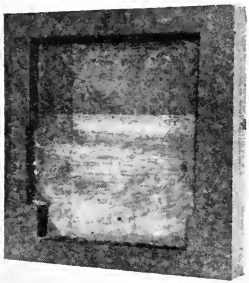


FIG. 92. *Underside of top*

This not only saves material and weight, but makes possible the use of a very simple method of fastening the top to the column. To do this, a board is fastened to the top of the column by using screws or nails. The column and board (Fig. 93) are then secured to the top by driving screws or nails upward through the board into the underside of the top. This method of fastening columns or legs to tops may be used in many places. The base is fastened to the column in the same manner. One cross rail extends entirely across and is secured by two screws, the other is cut in two and each end secured by two screws. This avoids the necessity of making a halved joint at the center. In order to polish the edges properly they must be veneered (page 69). If the wood is close grained and carefully smoothed, the veneering may be omitted.

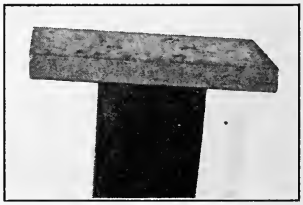


FIG. 93. *Top of column and cleat*

Round Top Taboret. This taboret (Fig. 94) is not only one of the nicest designs but also one of the best to illustrate several important points in cabinetmaking.

The sizes given in the drawing (Fig. 95), although the ones usually used, may be changed to the smallest support only a few inches high, for a flower jar, or to the height of a parlor table. If the sizes given in the drawing are used, the entire piece may be made from ordinary inch lumber.

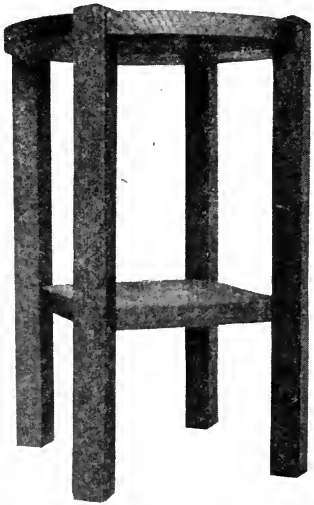


FIG. 94. *Taboret*

The larger sizes, because of the tendency of wood to warp or check, should either be made of thicker stock, or the top and shelf should be strengthened by cleats or crosspieces (Fig. 94).

When the top and shelf are simply plain boards, unsupported by cleats or similar supports, they must be of a material that is not likely to warp or split. Stock having the medullary rays parallel to the surface is best for such work (Fig. 44). Usually boards can be found wide enough for top up to 12 inches. Such boards must be quarter-sawed.

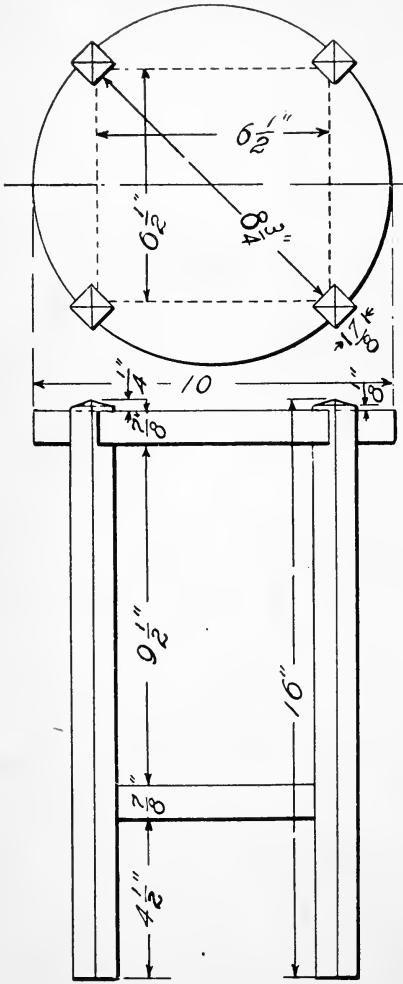


FIG. 95. *Taboret*

The first piece to be made is the top. If it is necessary to make the top of two pieces, they should be glued together. While waiting for the glue to dry, the legs or the shelf may be made.

Dress the top to a level surface and to the proper thickness. With the compasses, strike a circle the size of the top. The compasses may be used on the back side or the face side. If used on the face side, a small block of wood should be held, or slightly glued at the center (Fig. 96), so that the stationary leg will not make a hole in the top. If the circle

is drawn on the face side, any roughing of the edge in sawing or chiseling will be on the under side.

After drawing the circle, the waste material may be removed by sawing close to the line with the handsaw, as shown at *A* and *B* in Fig. 86, or the compass saw may be used as shown in Fig. 97. The edge may be finished by using the chisel. The chisel must make a shearing cut, as in working ends and joints, or in trimming the circular end of the bench-hook. ("Elementary Woodwork." See also Fig. 85.)

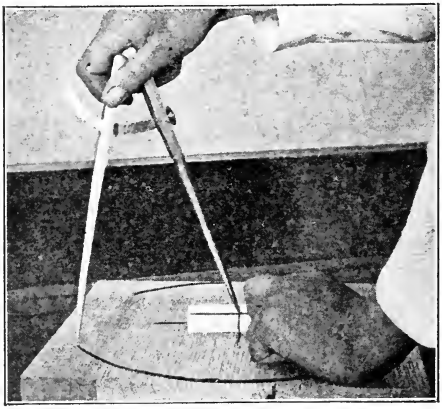


FIG. 96. *Block under leg of compasses*

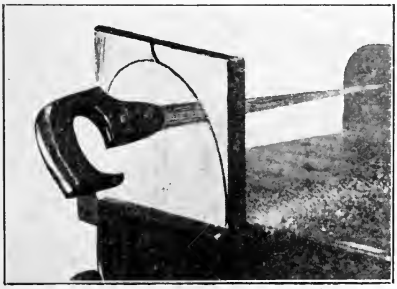


FIG. 97. *Using compass saw*

Some prefer to smooth the edge by using the smooth plane (Fig. 174). This is probably the best method for circles 12 inches in diameter and over. Some prefer to use the plane on even

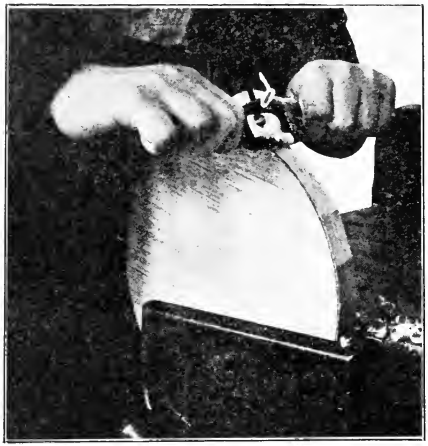


FIG. 98. *Spokeshave in use*

smaller circles. Large circles may be first roughed off with a drawshave as shown in Fig. 173. A good spokeshave may be used for this purpose (Figs. 98 and 99), but most people will find the chisel or the plane easier to use, and will do better work with them. Whatever method is used, be sure to test the edge carefully at every point with the try-square (Fig. 100). Notice that the beam of the try-square always points toward the center of the circle. This is very important, for a slight variation in the position of the head of the try-square may make a great difference in the value of

FIG. 99. *Spokeshave in use*

the test. This same principle applies to the testing of all curved edges.

If the legs are to be worked from a board or a plank by hand, first joint the best surface and the best edge so that you can draw gauge lines for exactly the proper widths, and rip close to the lines. You will thus avoid much hard work in planing. After one piece has been ripped off, rejoint the edge and gauge for the next piece. Always be careful to saw so close to the lines that a very little planing will be sufficient to make the edge a true surface.

FIG. 100. *Testing round edge*

As these pieces are to fit into notches, it is essential that they be very smooth and square, and all of the same size at each end. Line what is to be the top end of each leg and square it carefully, using the chisel after sawing near the line. Clamp the legs together as directed on page 26, and draw a knife line for the bottom end, for the dowel or screw which will enter the shelf; and

also for the dowel or screw at the top. Draw a pencil line for the chamfer around the top end.

Remove the clamps and draw the knife lines entirely around the bottom of each leg; also complete the pencil lines around the top end for the chamfer. Complete the chamfer as directed under the topic, "Finishing Ends," page 42.

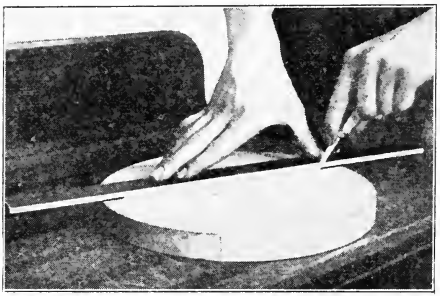


FIG. 101. *Laying out notches*

Set the gauge at as near half the width of the leg as you can, and draw two lines at each place for a dowel or screw—one line with the head of the gauge against the face side, and the other line with the head of the gauge against the opposite side. This is to make certain of the center of the piece. If it results in two gauge lines, set the spur of the bit between the gauge lines and exactly on the knife line. As these holes have much to do with keeping the taboret in proper shape, you should do your very best to bore the holes exactly right.

Notches for the Legs. After the edge of the top has been worked to a true circle and square with the surface, lay out the notches for the legs. To do this, find the four equal parts of the circumference,

and make knife marks at the edge. Draw a short line toward the center from each of these marks by laying a straight edge across the piece at the opposite marks (Fig. 101). Number the legs, and also the points at which the notches are to be cut. Find the center of each leg at the upper end, and make a small knife mark on the edge. Place the leg, as shown in Fig. 102, and mark the width where the opening is to be cut. Be careful to use each leg at the place it is to fill. With a straight edge draw lines from these marks the proper distances for the depths of the openings. By placing the straight edge at the marks of the two opposite gains the lines will be parallel (Fig. 101). Place the top in the vise, and draw lines across the edge. Use the try-square as shown in Fig. 103, and then draw lines on the back or under side of the top, the same as on the face or top side. (Fig. 101.) In drawing use a knife for all of the lines.

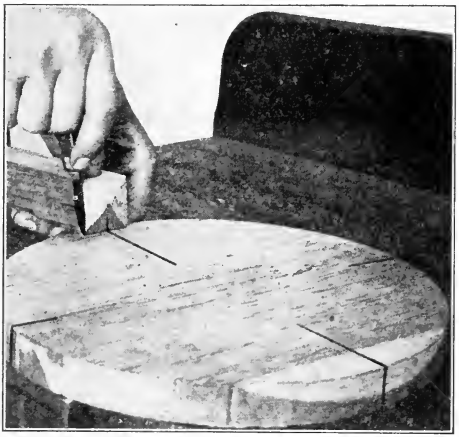


FIG. 102. *Marking width of notch*

To mark the depths for the opening, make a block as shown in Fig. 104, having two ends of exactly the same width, and then mark *C* exactly at the center. Place this block against the edge with the point *C* exactly at the center line of the top, and, with the gauge set for the proper space, draw a line as shown in Fig. 105.

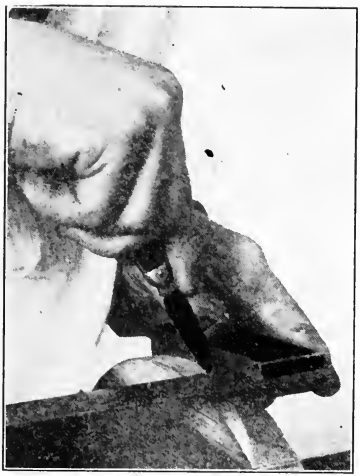


FIG. 103. *Lining across an edge*

It is not essential that the block fit the circle. If the two ends touch the circumference, and the point *C* is near enough to be set to the line, the gauge will make a line parallel to a tangent at the center of the opening, or at right angles to the radius.

If you are careful to hold the piece in the vise, as shown in Fig. 106, and saw close to the line, leaving just enough to smooth with the chisel, much time will be saved. You will need the ripsaw for two of the notches and the backsaw for the other two. After ripping at the sides

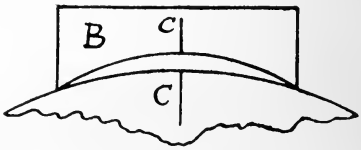


FIG. 104. *Sketch of concave block*

of the notch the waste material may be cut away, the same as in working dovetail. Find the center of each notch and bore the holes for the dowels. Be sure to bore them straight, or the dowels will throw the piece out of square.

FIG. 105. *Marking the depth of a notch*

After you have completed the top, dress a piece for the shelf. If you are able to work to your lines with considerable exactness, it will be much quicker to lay out the shelf according to the drawing, and finish it before testing it with the top. If you are not very accurate in your work, you may clamp the piece to the top, as shown in Fig. 107, and with the knife point scribe a line at the inside of each opening and make a mark exactly below the dowel hole, or, what is better, at the bottom end of the line which was drawn to locate the dowel. Mark the shelf with

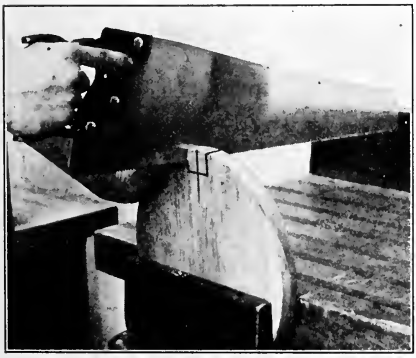


FIG. 106. *Sawing gain in vise*

the same numbers as the legs and openings in the top, so that you will be sure to place the shelf properly after it has been finished. Set the gauge to half the thickness of the shelf and make lines at which to bore holes for the dowels.

FIG. 107. *Scribing corners of shelf*

Glue a dowel into each hole in the legs, being particular to have it exactly at right angles with the surface. After the glue has thoroughly hardened, put the legs in place to see if all fit in properly.

Look for wind and also to see if the joints are all tight. After being sure that all is correct, glue and clamp the pieces as shown in Fig. 108.

To make the project easier, lag screws (Fig. 109) may be used instead of the dowels. This will avoid the necessity of using clamps. Although lag screws may be

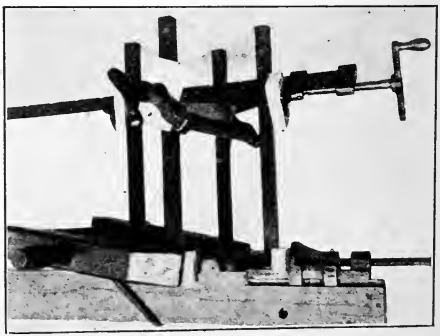


FIG. 108. *Clamping taboret*

used on such simple pieces, their use should be discouraged, and whenever practicable some method in keeping with ordinary methods of furniture construction should be employed.

FIG. 109. *Lag screw in taboret*

Before boring holes for lag screws, read what is said about boring with twist bits and gimlet bits. In order to be sure of having the holes the correct size, bore in a piece of scrap and insert the lag screw. The screw should fit loosely in the leg, but the holes in the top and shelf should be as small as can be used without splitting the pieces.

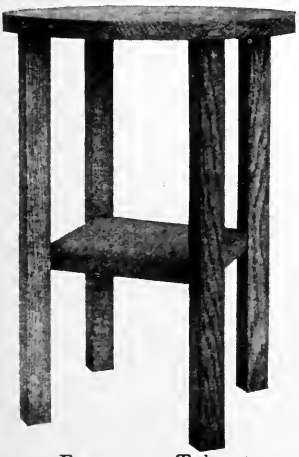


FIG. 110. *Taboret*

If you have made the openings in the top square, and the shelf corners square, the taboret should be straight and square as soon as the screws are in place. After all has been put together apply the finish, or take it apart and finish each piece separately.

Another Taboret. This taboret is similar to Fig. 94. The chief difference is that

it is fastened together with dowels beneath the top instead of at the edge. By making the taboret as shown in Fig. 110, the putting together is somewhat easier, as the legs may be first fastened to the shelf and then to the top.

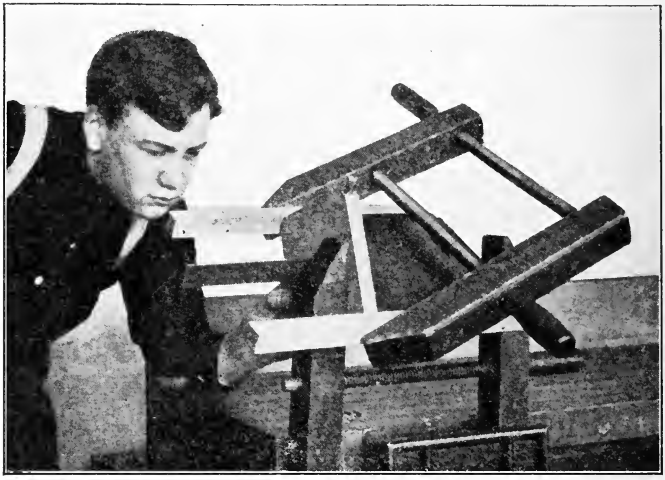


FIG. 111. *Gluing taboret*

In using this method, the parts may be gotten out in shape and size according to the drawing, and then the dowels glued into the shelf. Two legs are then glued to place (Fig. 111). A board is placed between the legs at one side of the shelf and a try-square at the other side. This board is made square so that as it is pressed against the shelf by the clamp it will hold the legs square. The try-square is used to see that the legs are at right angles to the

shelf. After two legs are thus secured and the glue dry, the other two are placed in a similar manner.

The next part of the work is to fasten the legs to the top. Lay out the under side of the top, locating the places where the legs should be secured. If there is any variation from the drawing, see what can be done to adjust it, and if necessary, scribe around each leg. Locate the place for the dowel at the center of the top of each leg, and the corresponding place in the under side of the top. Bore the holes about 1½ inches into the legs and as deep into the top as you can, and be careful not to mar the surface of the top with the bit spur.

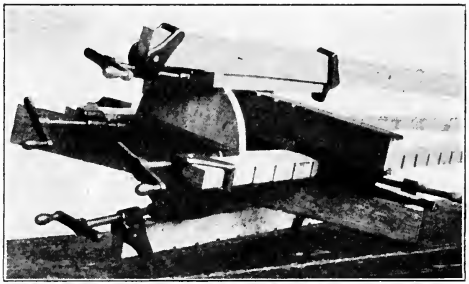


FIG. 112. *Gluing top to legs*

Carefully fit the dowels into the top, gluing them to place and allowing the glue to dry before putting the top on to the legs. This will avoid the liability of the dowel being pressed up through the top in putting the top in place. Try the top in place before applying the glue. When all is right, glue and clamp, as shown in Fig. 112. Notice that a piece is placed across the top to avoid splitting it. Short pieces are placed over the other two legs. You

may not require more than four clamps. One of the other clamps is to keep the piece square and one is to hinder the breaking of the dowel joint at the shelf corner.

FOOTSTOOLS

Dimensions. This design (Fig. 113) may be of any height from 8 to 14 inches. The width and the length should correspond to the height; but it is not essential that the width and the length be the same. It may be shaped similar to Fig. 119. If the stool is to be of a small size, the parts may be united with dowels. Read the directions for selecting and jointing face edges (page 11), for making tapered legs (page 37), and the remarks on doweling (page 35).

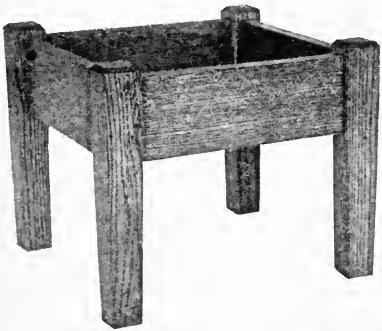


FIG. 113. *Footstool*

The footstool shown in Fig. 113 has side rails made of $\frac{7}{8}$-inch stock and they are 3 inches wide. The legs are of $1\frac{3}{4}$-inch square stock and are 8 inches long. They are $1\frac{1}{2}$ inches square at the bottom. The total width of the footstool is 12 inches.

Jointing Ends. If you are to use dowels, clamp the four pieces together (Fig. 11), and draw a line

across each end. These lines should be exactly the correct distance apart for the length of the pieces, or the space between the legs. If the ends are quite true, plan to locate the lines so that they will be either near enough to the end to admit of easily finishing with a plane, or else far enough from the end to allow the use of a saw. In dressing the ends with the plane, be very careful to make them exactly square, as tested from both the face side and face edge. Plane from both directions, so that you will not split the corners. "End Planing," in "Elementary Woodwork."

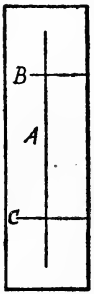


FIG. 114. *Marking for doweling*

Doweling. After all the ends have been made perfectly square, and the pieces of correct length, locate the dowels. First, draw a line nearly across the ends of each piece near the center *A*, Fig. 114. Next, set the gauge to $\frac{3}{4}$ inch and draw lines *B* on each piece. Then set the gauge to $2\frac{1}{4}$ inches, and draw lines *C*. In the places where these lines cross is where the spur of the bit should be set for boring the holes for the dowels. These holes should be $\frac{3}{8}$ inch in diameter and about $1\frac{1}{2}$ inches deep. A $\frac{7}{16}$-inch hole may be used, if carefully bored. Be very careful to follow the

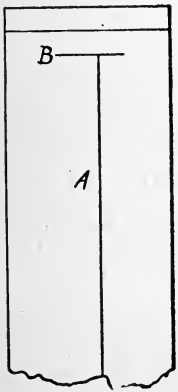


FIG. 115. *Marking for doweling*

directions for boring, so that the holes will be perfectly straight and at right angles to the surface.

The holes in the legs are located by drawing a line (*A*, Fig. 115) so that the surface of the rail will be about $\frac{3}{8}$ inch from the outside of the leg, and then placing a rail on the leg as shown in Fig. 116, and marking the spaces. If the rail is not to be flush with the top of the leg, a line should be drawn on the leg, showing where the upper edge of the rail will come. This is shown at *B* in Fig. 115.

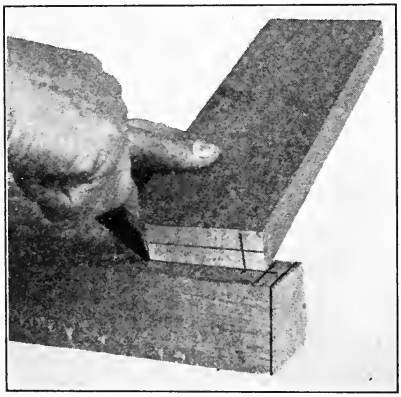


FIG. 116. *Marking for doweling*

If care has been taken to mark the ends of all the rails alike, one end may be used to mark all the places for dowels on the legs. If there is any variation in the lines, the rails should all be marked at both ends with a letter or figure, and corresponding marks made on the legs, so that each end can be returned to the same place. These marks should be placed where they will not be removed in scraping or sandpapering.

The holes in the legs should be bored about one inch deep, or until they meet. If deeper holes are

desired, two of the rails may have the holes located ½ inch and 2½ inches respectively from the face edge, and the holes in the leg to correspond. This will hinder their meeting and admit of the holes being 1¼ inches deep.

Either a machine-turned dowel rod or one made by hand may be used. (See what is said about dowels in Part III.)

After a sufficient amount of dowel rod is at hand, cut it into pieces about 2½ inches long. See that the rod fits the holes as tightly as it can be forced in and yet be removed.

Gluing. Place glue on about 1¼ inches of one end of each dowel, and in each hole in the rails. After the glue has dried until it is almost glazed, drive the dowels into the holes, being very careful to leave a sufficient amount projecting to enter the legs. After the glue is thoroughly dry, clean off any surplus glue and place the pieces together, clamping them to see if they are all right. If the joints draw up properly, take the pieces apart and put glue in the holes, on the pins, on the surface of the legs, and on the ends of the rails.

This glue should dry considerably before the parts are clamped, but it should not dry as much as on the pins before they were forced into the rails.

Remember that after the glue has dried sufficiently for placing the parts together, the pins cannot be driven to place but must be forced into the

holes by the steady pressure of the clamps. This is often necessary in forcing the pins into the rails. Glue the ends together first, being careful to follow the general directions given for scraping, finishing, gluing, and clamping.

Mortises. This footstool may be made with mortises and tenons, the same as Fig. 119. When mortises and tenons are used, there is a likelihood of the glue being forced into the side mortises while gluing the ends. You should, therefore, examine all the side mortises carefully before attempting to clamp the sides together, to see whether, in gluing the ends, any of these mortises have been partly filled with glue. Before gluing the sides to place, clamp all together to see if the joints are tight. Look carefully to see that the piece is square and out of wind.

This footstool may be made for different tops as shown in Figs. 117, 133, or 138.

Flowerpot Stand. If made a little higher in proportion to its width and supplied with a board top similar to the chair (Fig. 127)—but set between the rails and about $\frac{1}{4}$ inch below their edges—it is a good flowerpot stand. It may be further modified by using one or more square rungs similar to the spindles used in Fig. 159.

Upholstered Footstool. This stool is similar in shape to Fig. 113. The legs are made as described on page 37. The rails are laid out and tenons worked

the same as if the sides were to be finished straight. The mortises are worked as described on page 28. The chamfered ends are made as described on page 43. Read the directions for making Fig. 113.

After you have finished the tenons, draw lines for the curve at the bottom edge of the rails. This may be accomplished by sketching free-hand one-half the curve on a piece of thick paper. Then fold the paper and cut to the line. After you have a line that is satisfactory, lay the pattern on the pieces and draw the lines with a pencil. Notice in the drawing (Fig. 118) that the curve does not extend entirely to the legs. This curve may be drawn with the compasses as indicated in Fig. 118.

FIG. 117. *Upholstered footstool*

The drawing (Fig. 118) gives the sizes of the stool photographed, except the curve, but the article may be made either larger or smaller. For legs up to 14 inches long stock $1\frac{3}{4}$ inches square is large enough; $\frac{7}{8}$ inch is thick enough for the rails.

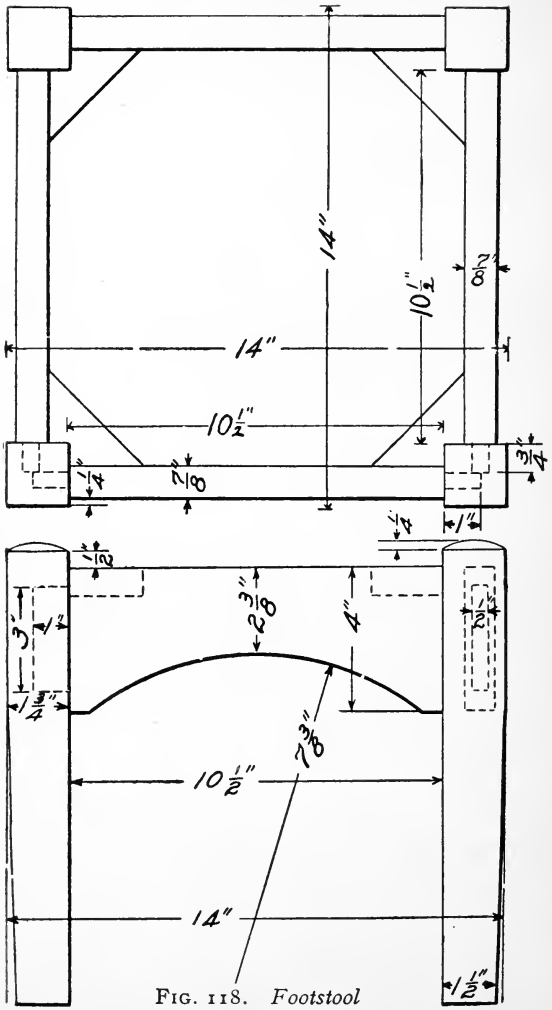


FIG. 118. *Footstool*

The width should be proportioned to the height of the legs. The lower edge would be nearer straight if the rail were narrower, and more curved if it were wider.

To remove the waste material, saw with a compass saw close to the line and finish with a chisel, spokeshave, or scraper. If the sawing is done properly, very little finishing will be required. In no case use a file, for it does not leave a properly finished edge and this would stamp the piece as having been done by one who does not understand how such work ought to be done. Do not be satisfied until the curve is regular, smooth, and square to the very edges.

Finally, it should be smoothed with sandpaper. The paper should be held as it is in sandpapering a chamfer (Fig. 32). Do not use a rounded block, for it will certainly ruin the edges.

The taper of the legs may vary, as their size may also. The top may be upholstered either as shown, or like the chairs in Figs. 138 and 147. If the woven leather is to be used the triangular blocks at the corners should be omitted, as these are to receive the tacks in fastening the upholstering about the corners.

Oblong Footstool. This footstool is not difficult to make. The instructions given in the general directions cover substantially every feature of making. This footstool may be made to receive any of the tops shown in Figs. 117, 138, and 147.

The sizes may also be varied. It should not, however, be much larger than the dimensions given in the drawing (Fig. 120) unless the stock for the legs is of a larger size; 2¼-inch square legs go very well with rails of these sizes. The amount of work is lessened by making the lower rail only ⅞ inch square.

As the tenons meet at the corners, one set should be shorter than the other set. All may be worked the same length, and after the end rails have been glued to place, the tenons on the side rails may be cut to length. Do not attempt to miter the ends of the tenons, for if your work is properly done this will be unnecessary, and if the joints are not well made, the mitering will do little if any good. Do not forget to glue the end rails in place first, then test the side rails by clamping to place before gluing. Read the directions for clamping and finishing before applying any glue.

FIG. 119. *Oblong footstool*

In Fig. 121 is shown how the top rail of a chair or stool may be rabbeted so that the leather can be fastened to the edge of the rail, and yet have a

finished edge of wood outside the leather. A small block should be fastened at each corner so that the leather can be properly tacked around the inside corner of the leg. This is shown in Fig. 121.

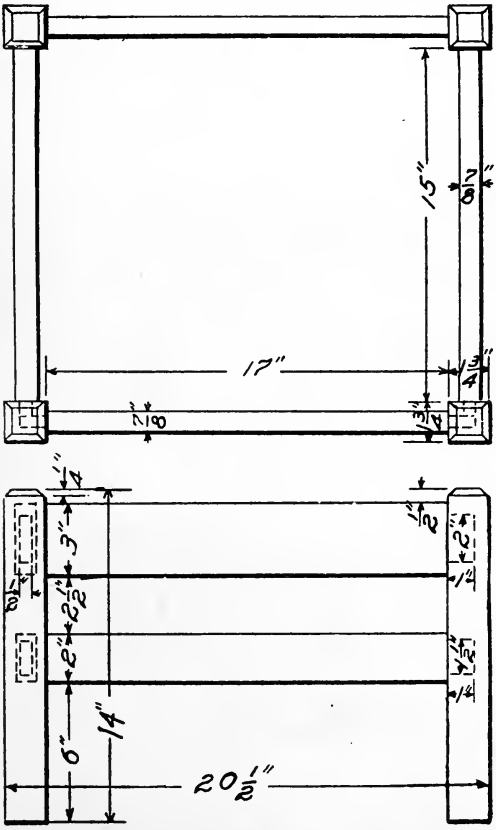


FIG. 120. *Footstool*

This same plan may be used in covering seats with leather which have a frame around them similar to Fig. 135. The frame would be made as shown, and then a place for the leather rabbeted around the inside edge, and the inside frame omitted. Such a seat is really much nicer for some purposes, as it is stronger and the leather does not wear out at the edges.

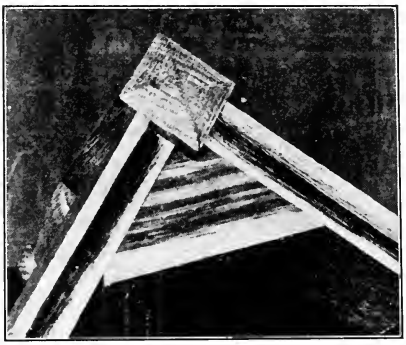


FIG. 121. *Rail rabbeted for leather*

Unless the footstool is of small size the rail should be 1½ inches thick to allow a sufficient width of rabbet.

Rush Seat Footstool. This footstool (Fig. 122) is a little more difficult to make than the oblong footstool (Fig. 119), because the rails differ in size and position. This makes it necessary to exercise considerable

FIG. 122. *Rush seat footstool*

care in locating the mortises so that the legs will all face as desired, and be right end up.

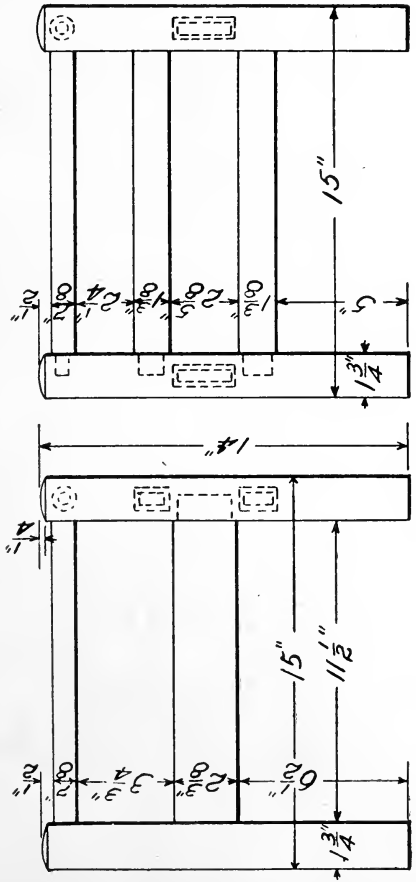


FIG. 123. *Footstool*

If you will stand the legs on the bench in the position you wish them to occupy, and then sketch the location of each mortise (Fig. 14), you will be quite sure to make no mistake when you lay them out.

The top rungs (Fig. 123) of this footstool are simply cylinders. They may be planed to shape, as described in "Elementary Woodwork," or turned in the lathe. As they are covered the entire length, they need not be very smooth. In the old rush-seated chairs, these pieces were often made entirely with an ax. They may be a little larger than the holes and fitted by whittling when the parts are put together. As the holes for the rungs meet at each corner, you must be careful about examining them after the front and back are together, before attempting to clamp the sides to place.

In making this footstool, read what is said in Part I about face sides, laying out work, mortises, tenons, clamping, gluing, chamfering, scraping, finishing, etc. The size (as given in Fig. 123) may be modified to suit. The rails must not be located so near the rungs or top of the legs as to leave insufficient room for drawing the rushes around the rungs. The space given in the drawing is about as small as it can be to allow of convenient seating.

This design may be modified by using cord, rattan, or leather for the top. Instead of the cylindrical pieces, a rectangular rail and a solid or woven leather top (Figs. 117 and 138) may be used. If arranged

for a soft upholstered top, the design becomes practically the same as the bottom of Fig. 125. There is an advantage in this arrangement of the rails (Fig. 123), as all the tenons may be full length. It is a stronger design than Fig. 119. A very little taper—about $\frac{1}{16}$ inch on a side—improves the appearance of the legs. The taper should extend only up to the bottom edge of the lowest rail.

CHAIRS

Read all the directions for selecting and working the face sides (page 11), making legs (page 35), and laying out mortises and tenons (pages 14 to 35). Read also the full directions for clamping and finishing (pages 84 and 79).

This design (Fig. 124) is intended for the upholstered seat (Fig. 125), but may be altered to receive a different kind of upholstered seat (Fig. 147), a wooden seat (Fig. 127), or a woven leather seat (Fig. 138). The sizes given in the drawing (Fig. 126) may be changed to make either a higher or a wider chair.

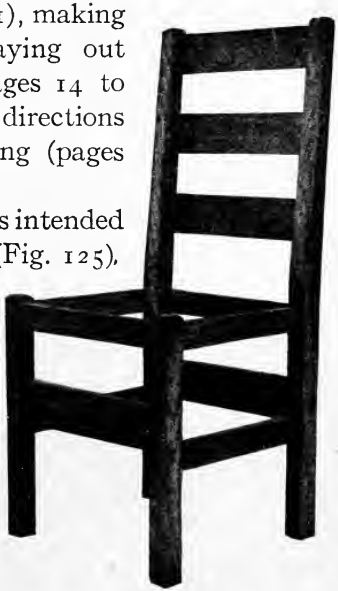


FIG. 124. *Chair*

The legs may be of $1\frac{1}{4}$-inch stock, and the rails of $\frac{5}{8}$-inch or $\frac{1}{2}$-inch stock. The tenons will then be shorter and thinner and must be very carefully fitted.

The back may be altered by using a piece vertically (Fig. 146), or small square pieces, as shown beneath the arms in Fig. 159. This will allow the rails to be made narrower, and consequently the whole chair will be much lighter. Go over all the dimensions and then compare this chair with the others. Notice the differences in the sizes of stock and also in the height of back and seat. The number and the length of rails is also to be considered. In all changes in the number and size of rails be careful about the spacing. Avoid placing rails too near the lower end of the legs. Also avoid weakening the upper end of the leg with too long mortises. The meeting of the mortises in the leg should also be considered. The legs may be straight. This will save much work. The amount of work may be greatly increased by making all the rails narrower and increasing their number.

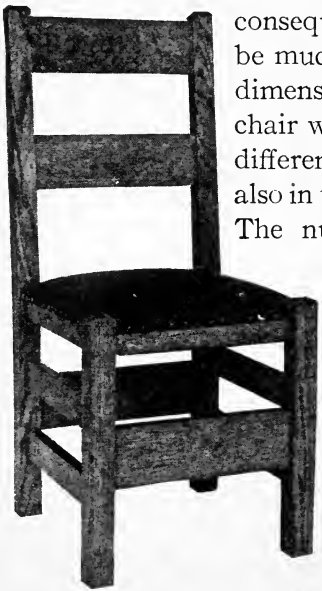


FIG. 125. *Upholstered chair*

A child's chair may be made by using this design with dimensions changed. To reduce the plan, first determine the height of the seat and then calculate the other sizes. If the work is well done the small

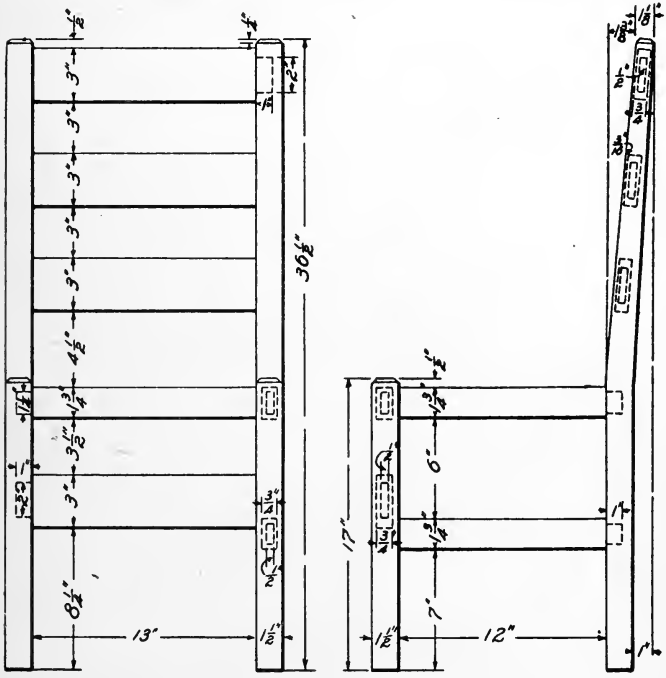


FIG. 126. *Chair*

chairs may be made of basswood, yellow pine, maple, or some other similar wood.

For children's chairs, or for larger chairs to be used out of doors, the seat may consist of narrow

slats resting on strips nailed to the insides of the front and back rails. The ends of the slats should form good joints with the inside surfaces of the rails. Chairs for out of door use may be oiled or painted instead of varnished. Make a complete working drawing of what you wish to make before beginning work.

Wooden Seat Chair. This chair (Fig. 127) is given as an illustration of one form of wooden seat. Although this kind of seat is appropriate for some chairs, it cannot be used in all places and, therefore, you should consider where the chair is to be used before deciding upon the style of seat.

This seat may extend over the ends of the front legs. If it does, it should be rounded more on the top edge. The grain of the wood should be parallel with the side rails. Such seats may be used on footstools (Figs. 113 and 119), chairs (Figs. 134 and 148), and the hall seat (Fig. 162). The style and height of

FIG. 127. *Wooden seat chair*

legs, the number and size of rails, may vary quite as much in chairs for wooden seats as in those for other styles of seats.

Before beginning work, make a complete work-

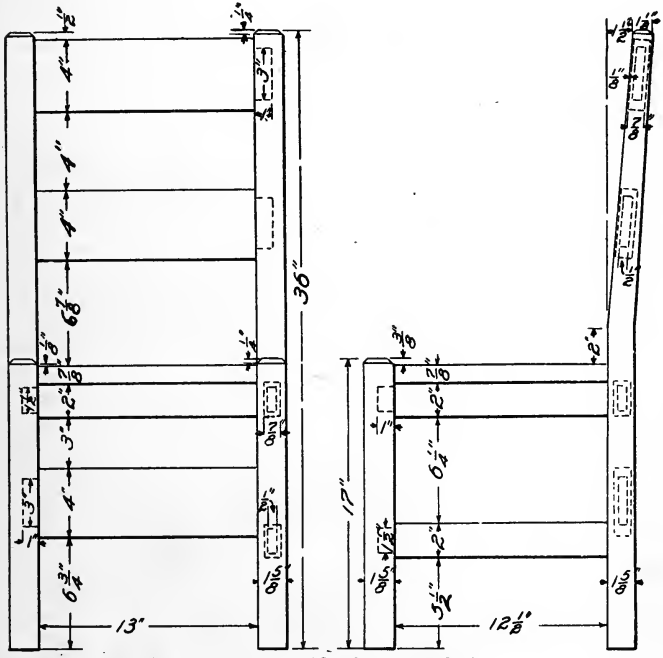


FIG. 128. *Wooden seat chair*

ing drawing of the style you wish to make. The sizes may be varied from those shown in Fig. 128 to those in Fig. 126 or Fig. 148.

In making this chair, read what is said under

each topic: "Selection and Arrangement of Material" and "Face Marks" (page 11); "Legs" (page 35); "Mortises and Tenons" (pages 14 to 35); "Glue Joints" (page 57); "Clamping" (pages 84 and 95); "Smoothing" (page 79); and "Finishing Materials" (page 257).

FIG. 129. *Marking to fit seat*

In making the seat, first glue together at least two strips, making a piece of sufficient width. True the surfaces, the edges, and the end which is to be at the back side. Lay the seat in place (Fig. 129), and with knife and try-square draw lines at the inside of each leg. Measure the required distance from the end and draw lines in from each edge with knife and try-square. Carefully remove the piece at each back corner and fit to place. After the seat has been fitted to the back legs, place the chair in the position shown in Fig. 130, and scribe the seat for fitting to the front legs. Work very carefully, or the corners

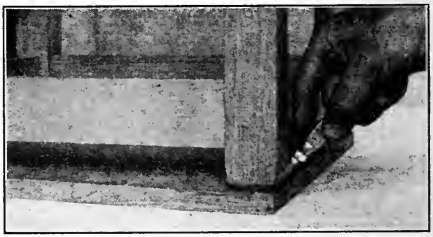


FIG. 130. *Scribing around front legs*

will not fit. Notice that the seat is not against the rails at the back legs as you scribe with a knife for cutting the openings for the front legs. (Fig. 130.)

After all the corners have been fitted, round the edges between the legs, bore holes as in fastening a table top (Fig. 80) for two screws in each rail, and fasten the seat to place. You may find it easier to do all the finishing on the chair with the seat removed. This seat may have a formed surface, or may be covered with leather, or the center may be cut out and upholstered, similar to Fig. 125.

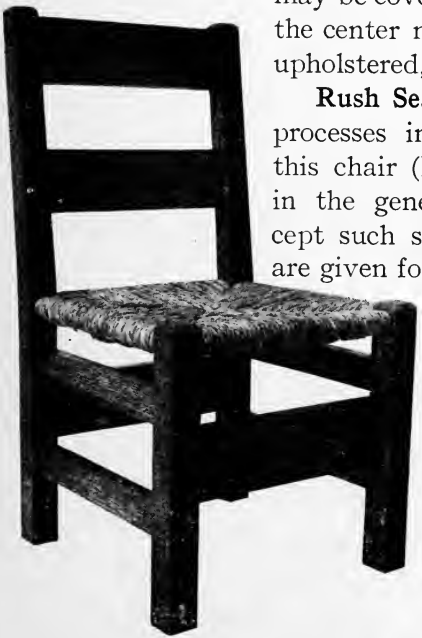


FIG. 131. *Rush seat chair*

Rush Seat Chairs. All the processes involved in making this chair (Fig. 131) are given in the general directions, except such special directions as are given for making the footstool (Fig. 122).

With the introduction of the rush seat a large variety of forms is suggested. From the most substantial construction, as given in Fig. 132, the design may be changed to the

straight round legs and round rungs of the home-made chairs of the early settlers.

In your school work, plan to make use of the more difficult construction in order to get the larger value from your work; the design may be changed

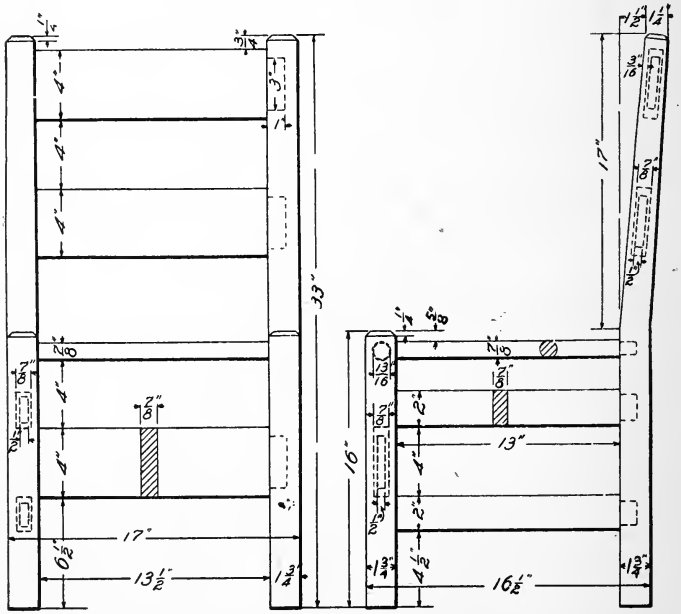


FIG. 132. *Rush seat chair*

by omitting two of the rails and by making the others smaller. This will require less work and yet teach the mortise and tenon construction.

As the rushes are not easily obtained, an imitation rush seat may be made of cord.

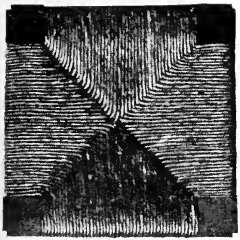


FIG. 133. *Rush seat*

In Fig. 133 is shown another style of rush seat. This seat may be used on any size chair or footstool. A board may be used inside of the rails instead of the frame and rush seat.

This seat is shown in position in Fig. 134. Such seats are suitable for the best chairs. It is made on a frame which should be carefully fitted inside of the rails. Fig. 136 gives the dimensions of the chair and frame for the rushes. The rushes are put on in the same way as are those in Figs. 122 and 131, except that the strand is much finer. If the seat is very long, as in the hall seat (Fig. 162), the rushes may be put on two or more separate frames.

In making these frames, the edges over which the rushes pass should be carefully rounded as shown in the detail drawing in Fig. 136. Notice that the inner edges of the frames are beveled to avoid breaking the rushes.

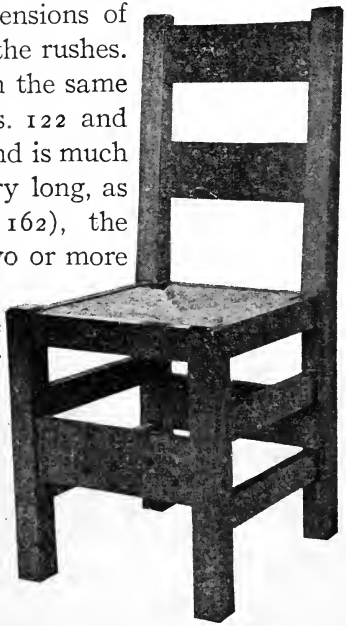


FIG. 134. *Rush seat chair*

A method of chair construction which is quite substantial, is illustrated in Fig. 135. The chair is made the same as Fig. 124, except that the top ends of the front legs are flush with the top edge of the rails, and a wide border is used around the seat.

In making the border for the seat, mortise and tenon the corners, and then fit the frame to the top, the same as if it were a solid piece. Instead of fastening it in place with screws, as would be proper for a solid seat, it should be carefully fitted to the rails and glued. Screws may also be used.

The inner frame and the rush seating are the same as shown in Fig. 133. Instead of the rush seat, the outer frame may be rabbeted and receive a leather seat, either plain or stuffed. Holes may be bored in the frame and a regular cane seat woven in. A reed seat may be woven over the inner frame, similar to the rush seat.

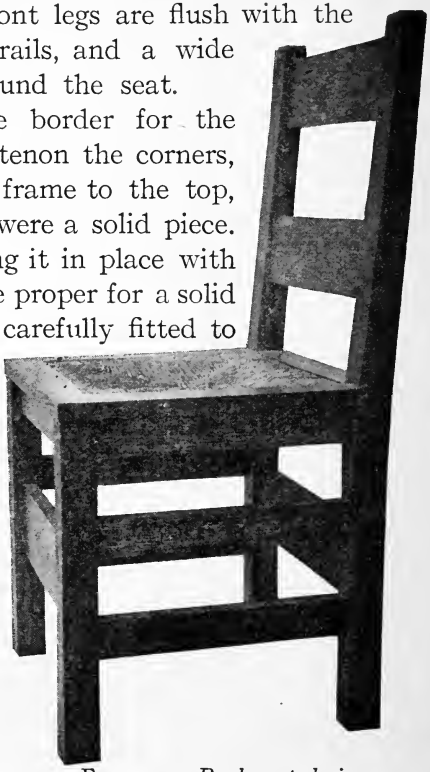
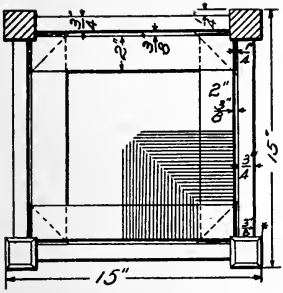
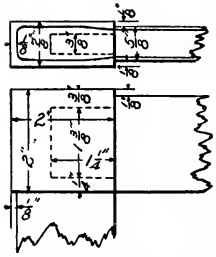


FIG. 135. *Rush seat chair*





Detail of seat frame

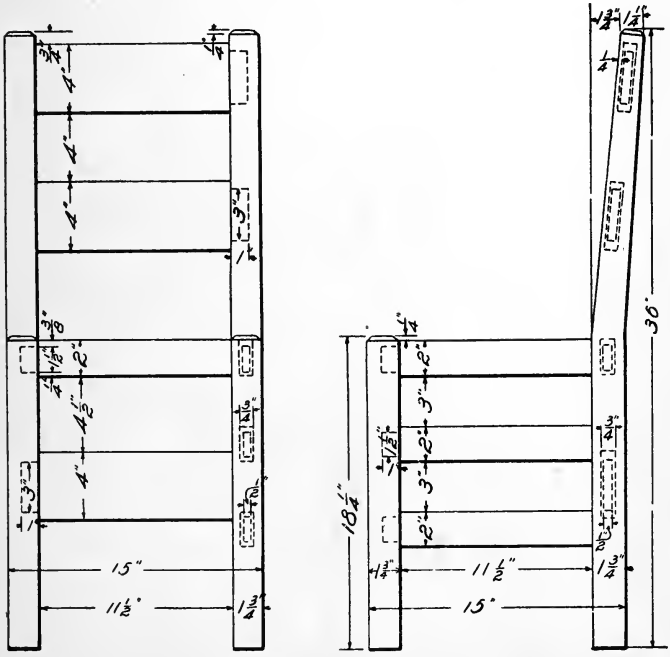


FIG. 136. *Rush seat chair*

Any of the designs having rails on a level with the top of the front legs may be modified to receive this style of seat. The shape and size of parts of the outer frame may be changed. Make a complete drawing before beginning work on the chair.

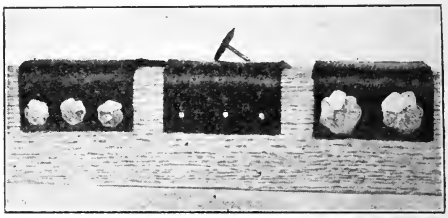


FIG. 137. *Ends of leather and nails*

Woven Leather Seat Chair. This chair (Fig. 138), is substantially the same as Figs. 125 and 134, with the exception that it has a woven leather seat. The directions for making it are the same as those given for Fig. 124. The sizes of the chair photographed are shown in Fig. 139.

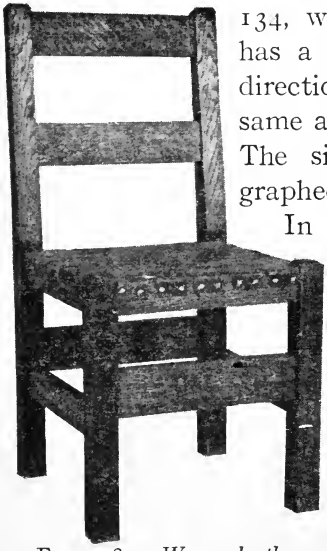


FIG. 138. *Woven leather seat chair*

In fastening the leather in place, first secure one end of a strip by nailing with tacks, small nails, or brads Then stretch the piece as tightly as you can, and fasten the second end. If the pieces have been cut too near the correct length, you will need some sort of pincers or pliers

with which to grasp the ends of the strips. Place outside strips tightly against the legs, and divide the space equally for remaining strips. Drive the tacks or small nails to place, and cover the heads with fancy nails (Fig. 137). This chair may be modified by using smaller stock or by using more and larger

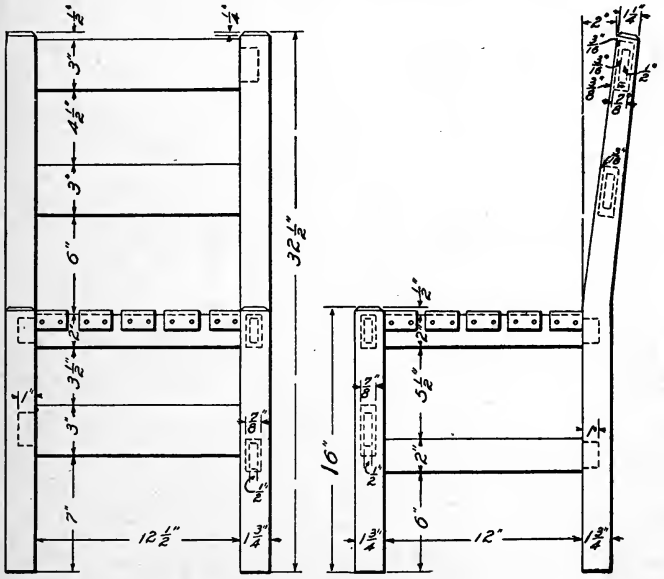


FIG. 139. *Woven leather seat chair*

stock (Fig. 148). This seat (Fig. 138) may be used on chairs or stools having legs with finished ends projecting above the rails. The leather may be fastened to rails of any width, or around rungs like those used in rush or rattan seats (Figs. 131 and 140).

Suspended Leather Seat Chair. A style of leather seat which requires a special frame is shown in Fig. 140. This is not difficult to make, nor would there be as much work on it as on Fig. 138 if it were no larger. In its smaller and more simple form (Fig. 142) it is one of the easiest chairs having mortises and tenons you can make.

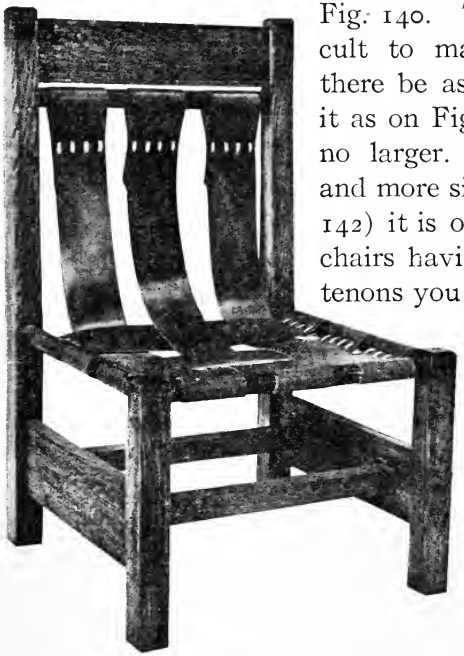


FIG. 140. *Suspended leather seat chair*

The directions for face edges, mortises and tenons, clamping, etc., given in the general directions include about all the instructions required for making these chairs. The length between the tenons of the two pieces beneath the seat is found by adding to the length between the tenons on the top back cross rail an amount equal to twice the space from the face corner of the leg to the surface of the side rail. In the drawing (Fig. 141) this is 18 inches plus two times $\frac{1}{2}$ inch. Should you use a different

size of stock or wish to locate the rails differently, the proper length may be easily determined in this manner. Instead of the two square cross rails, one wide rail may be used. In a very light frame the side rails may be much lighter, and turned rungs used instead of the cross rails.

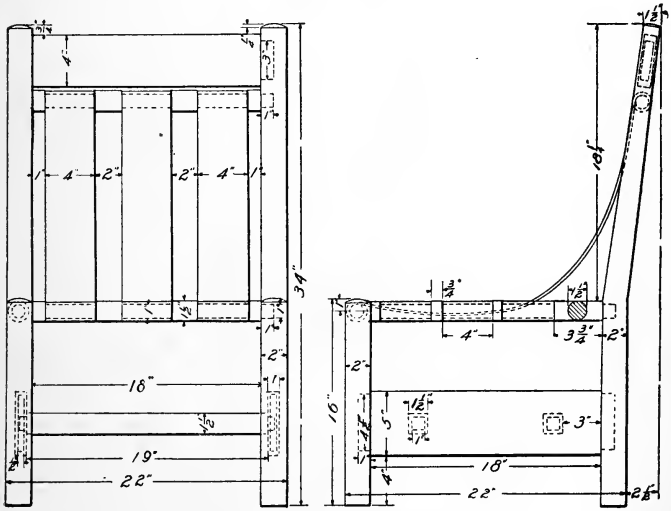


FIG. 141. *Suspended leather seat chair*

Probably no other design in this book offers a better opportunity for the use of the keyed mortise and tenon joints. The top back rail and the two side rails may have double keyed tenons at each end. (Fig. 16). The cross rails beneath the seat should have one key at each tenon, or if a wide cross rail is used it should be keyed the same as the side rails.

The leather may be folded and fastened around the round pieces (Figs. 140 and 143), or it may be nailed to the pieces (Figs. 137, 142, and 144). In the latter case, the rails are square and rounded only on the upper and under front corners. In Fig. 140 the pieces were turned in a lathe. In Fig. 143 is shown how the leather appears from the back of the chair. In Fig. 144 the leather is nailed at the front side with small-headed nails; having been nailed first at the back side with small nails and then with fancy-headed nails. Fig. 142 is the same as Fig. 144, except that one rail is omitted and the top rail rabbeted so that the leather will be flush with the surface of the rail.

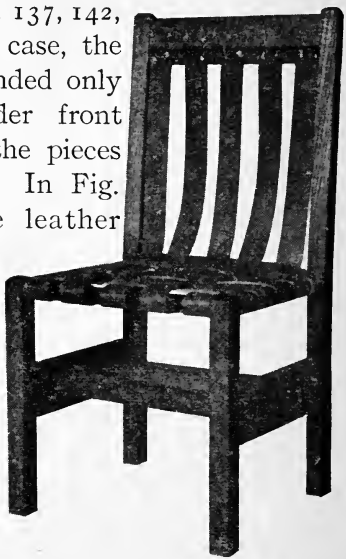


FIG. 142. *Suspended leather seat chair*

The leather is first nailed in the rabbet with small nails, and these are then covered with flat-headed fancy nails that will not project much beyond the surface of the rails. Either style of back may be used with the front and side rails shown in Fig. 138. This is an easier form of construction and is usually more satisfactory for small chairs.

All of these designs may be greatly modified in outside dimensions, and also in size of stock. The width and number of strips of leather, too, may be changed.

By studying Figs. 138, 140, 142, and 145, and by combining or modifying elements selected from each, a large number of good designs can be made. If you wish to get the most from your work, begin the preparation for your design by studying and measuring such chairs as you can find in your home or elsewhere. It is not enough to make the measurements, you should in every case attempt to discover why they are as they are. No rules worth while can be given for these sizes; for the variety of forms and reasons for them are so great that you would find it extremely difficult to apply any rule. Do not fail, in all your study of such forms as you find, to recognize the fact that many shapes and sizes are not what they ought to be, but what the manufacturers could easiest make. One point of contrast, which you will notice in comparing

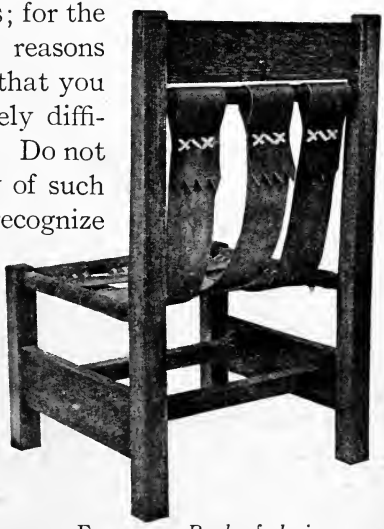


FIG. 143. *Back of chair*

Fig. 143 with many chairs of commercial design is the use of substantial square or thick stock instead of thin flat stock; placed with the wide surface so as to indicate strength which does not exist.

In the matter of leather and its fastenings you also have opportunity for much originality. From the use of one wide strip, laced at ends and sides, to the use of many narrow strips, laced or woven in intricate patterns, you will find ample opportunity for both study and work. There is not only opportunity to use leather of different shades to suit the color or stain on the wood, but the tooling of patterns may also find an appropriate place.

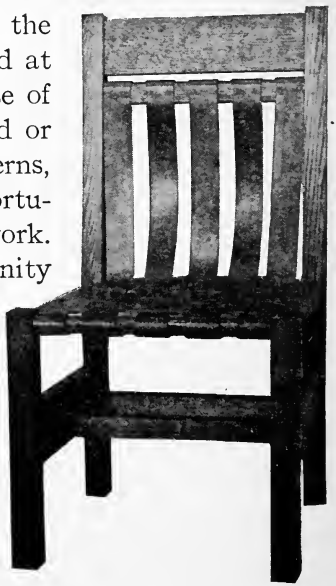


Fig. 144. *Suspended seat chair*

In applying the leather first nail on end of the short strips, then draw the piece as tight as you can and nail the other end. After the short pieces have been fastened, nail the top ends of the long strips with brads, the brads to be covered with fancy nails. Clamp a stout piece of wood across the seat, then draw the pieces as tight as you can and nail

them at the front. All the finishing should be done before the leather is applied.

The leather should be of a grade suitable for belting, and not such as is usually used for upholstering. It should be quite pliable, and smooth on the under side. Much of the belting leather is too stiff for such use. The safest plan is to procure leather cut from the side especially for such use. For light chairs the leather may be split to the thickness desired. Smooth and stain the rough side.

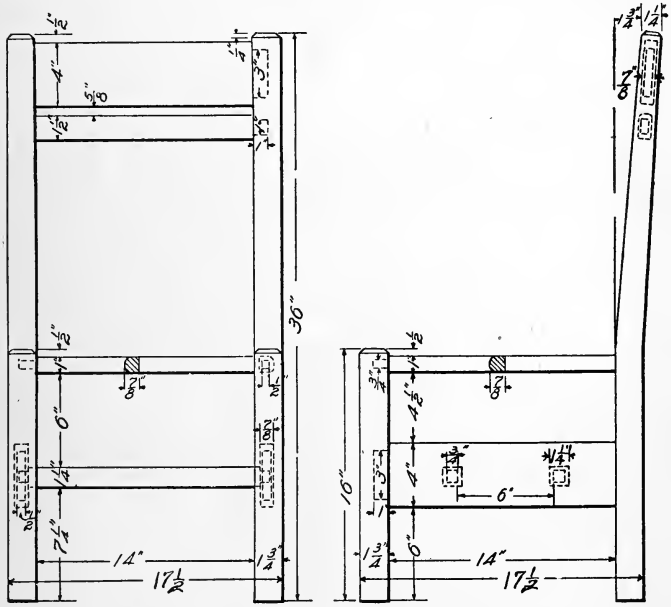


FIG. 145. *Suspended leather seat chair*

Upholstered Chair. This chair (Fig. 147) is still a little more difficult. Instead of there being two pieces at the side as in Figs. 124 and 138, there are three, and the wide rails are four inches wide instead of three inches, as in Fig. 124.

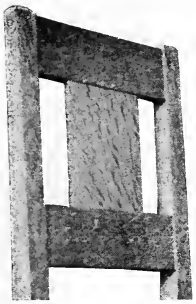


FIG. 146. *Chair back*

All the required directions for making and finishing are found in Part I under the topics "Face Marks," "Mortises and Tenons," "Smoothing," "Clamping," etc. Read all of Part I carefully before beginning work on this chair.

The sizes given in the drawing (Fig. 148) may be modified by using heavier stock, or by making both the seat and back lower. The top rail may be made of $1\frac{3}{4}$-inch stock

FIG. 147. *Upholstered chair*

to give more surface for the tacks used in upholstering. The desirability of this change depends upon what the chair is to be used for.

Fig. 146 shows a modification to correspond with the hall seat (Fig. 162). Two or more pieces may

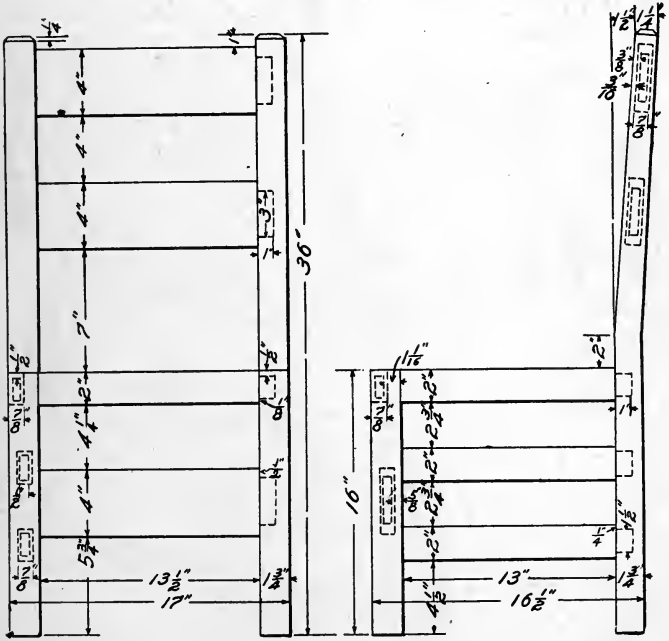


FIG. 148. *Upholstered chair*

be used in place of the single vertical piece in the back, or a number of squares (Fig. 159) may be used. The hall seat may have groups of narrower pieces or square spindles to correspond with the chair design.

Large Armchair. This chair (Fig. 149) is a desirable project for pupils of the first year in high school who have learned to make joints well. It is more difficult than the small chairs, because the pieces are longer and because close joints are required in the back. All the joints are simple, and if the

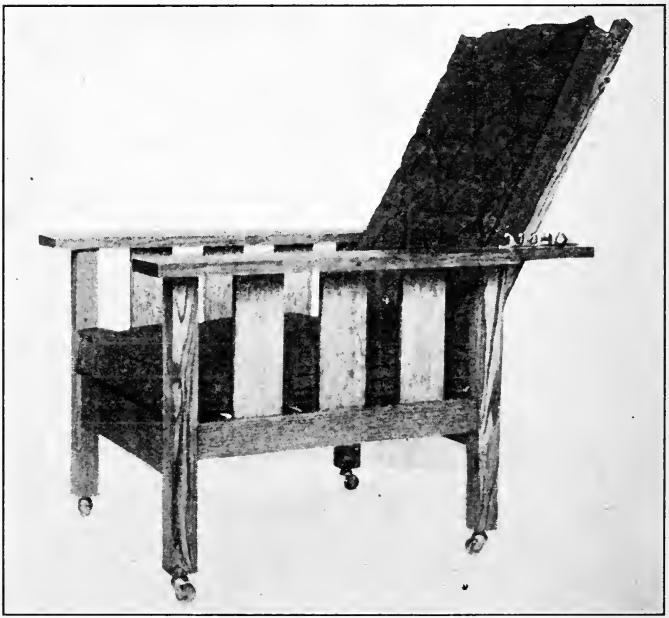


FIG. 149. *Large armchair.*

pupil is careful to have every piece out of wind, straight, square, and of proper size before laying out, he is not likely to have any trouble in making the pieces fit together at the first attempt.

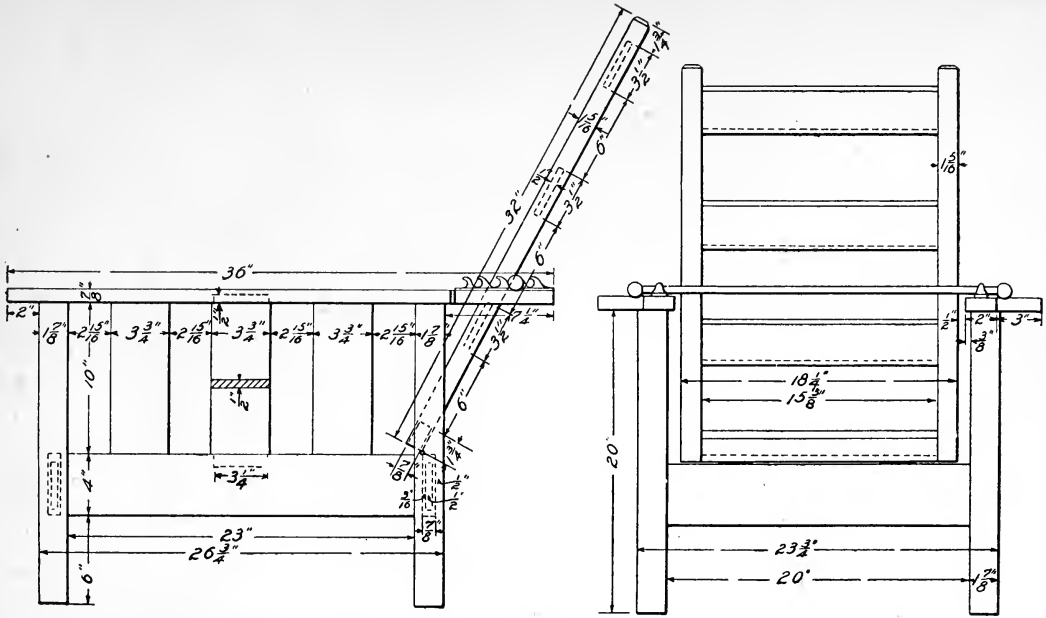


FIG. 150. *Large armchair*

Be particular to select the wood so that the arms, front legs, and the 4-inch piece used for the front rail show a fine figure.

The exact order in which the pieces are worked is immaterial. In working the legs and rails follow the general directions in Part I for such work.

Lay out and work the mortises for the vertical pieces before gluing the side rails in place. The spaces may be determined by spacing the rail and then transferring the marks to the arm by superposition similar to Fig. 13. By drawing light lines on the arms corresponding with the shoulders of the tenons on the rail, you will have points at which to locate the arms in marking the dowels. The position of the mortise in the width of the arm should be calculated from measurements on the drawing.

Clamp a front and a back leg with the piece for one side (Fig. 72), and if the joints are correct, glue them after scraping and sandpapering them as described in "General Directions" under "Smoothing," page 79. After the side rail and legs are glued together, the arms should be glued in place. (Fig. 73.)

In working pieces of this length and size you must be very careful to make good joints, for a variation in your work will show much worse than it will on a small piece.

The arms should be of selected stock and well finished. Joint the edges and finish the ends with the plane. Draw the lines for the small portion at

the back end with knife, try-square, and gauge. Saw close to the lines and finish with a chisel. Use a shearing cut, either laying the piece on the bench or holding it in the vise. Lay the arm on the bench, bottom side up, and place the legs in position on it, using the lines drawn for the inside edge of the legs in laying out the mortises. With the point of the knife blade (Fig. 151) make a mark at the side of the leg on both the leg and the arm at the same time. Make similar marks at the three remaining face sides of this pair of legs. Remove the legs and, with a gauge set to these marks, draw gauge lines to cross near the center of the end of each leg. With the gauge head against the face edge of the arm and set to each knife mark, extend the two lines on each arm, and with the try-square draw lines from the other two marks, crossing those drawn with the gauge. At the places on the top ends of the legs and at the two places on the arms where these lines cross, bore holes for dowels. Remember that the arm is thin and do not bore the hole too far.

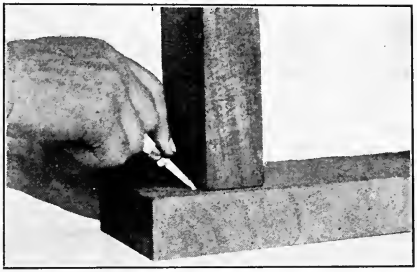


FIG. 151. *Marking for doweling*

Instead of using only one dowel in each leg, you may use two. In this case they are located as

shown in Fig. 152. Instead of one mark at each face side, two are made, and the holes are bored at the crossing of the lines drawn from these marks.

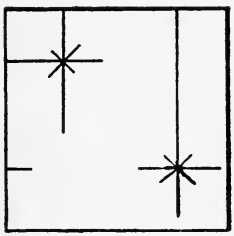


FIG. 152. *Locating dowels in legs*

Insert the dowels and place the arms in position; see if the front and back joints, also the joints at the ends of the vertical pieces, are all right. If they are, glue and clamp them. Glue the pins into the arms first, and then glue the arms to the legs. Clamp them as shown in Fig. 73. Test the frame for wind, square, etc. (Page 89).

The backs of these chairs may be modified to suit. In each large chair is shown a different style of back, yet many other styles are suitable. The most common fault in designing backs for such chairs is to make them too light. The stiles should be large enough not to be weakened by the tenons of the rails.

To support the cushions, strips are placed across the

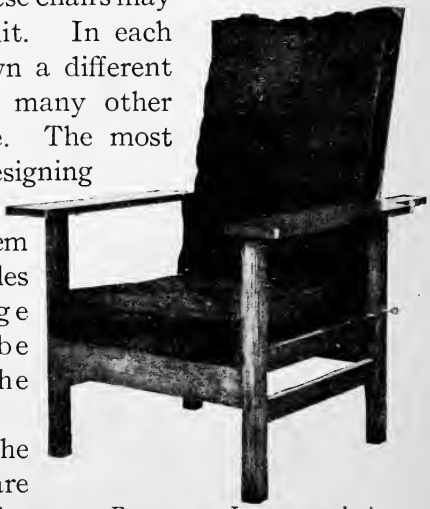


FIG. 153. *Large armchair*

FIG. 154. *Large armchair*

frame. These strips may extend either from front to back or from side to side. Their width is not material, and consequently they should be made of defective or discarded stock. However, these strips should be strong and somewhat elastic, and therefore should not contain any defects that might weaken them. Beneath their ends, and securely nailed and glued to the frame, are placed two strips to support them. There are many possible modifications of this design. Fig. 153 is a lighter frame and a little easier to make. In this design the side rails are so arranged that their tenons are not on the same line with the front and back rails. This makes it possible to use smaller legs.

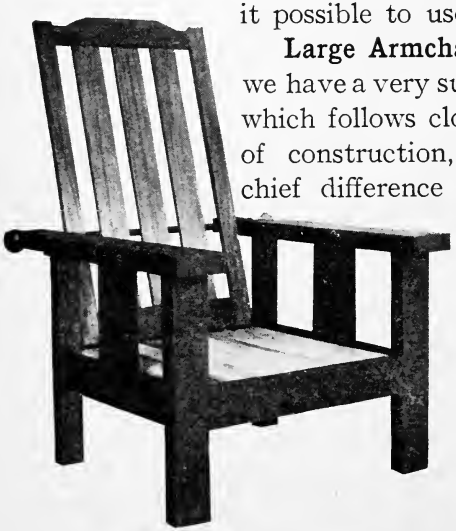


FIG. 155. *Large armchair*

Large Armchair. In Fig. 155 we have a very substantial design, which follows closely, in methods of construction, Fig. 149. Its chief difference is that the legs are not square. The other features may be used on either design. Fig. 156 gives the ordinary dimensions. Fig. 159 shows a style of filling for the side which

FIG. 156. *Large armchair*

may also be used on either design. Such spindles are suitable for many places—in chairs, tables, etc. They may be used either in a vertical or horizontal position. If the chair is to be held together with rods (Fig. 158), the seat frame is made separately (Fig. 157) and is placed in position before the rods are tightened.

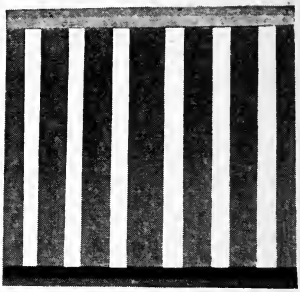


FIG. 157. *Seat frame*

Knockdown Armchair. Fig. 158 is very similar to Fig. 153. A modification of considerable importance, although scarcely visible, is the rods which extend entirely across both front and back just inside of the center of the front and back rails. In Figs. 61 and 62 these rails are shown with the grooves for rods. The grooves may be made with a plow or by several kerfs of a circular saw. These rods terminate in nuts at

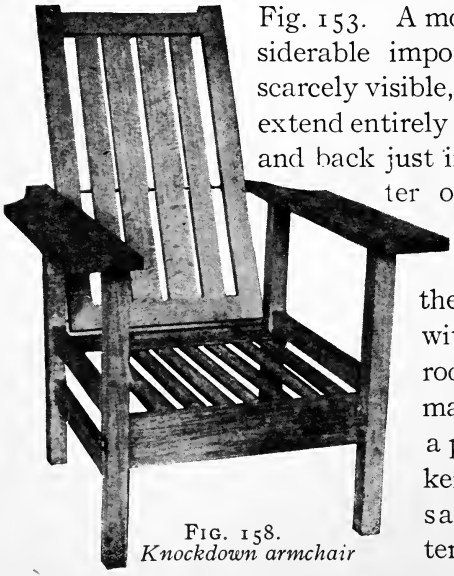


FIG. 158.
Knockdown armchair

each side. By removing the rods the chair is taken apart for packing. This arrangement makes it possible to cover the ends of the rods for the hinge and for the support of the back. In Fig. 158 the side rails are 22 inches between the legs, and the front and back rails 20 inches. There are several methods of hinging the back. Fig. 155 shows hinges connecting the lower rail of the back with the upper edge of the cross rail, and an adjustable rod behind the back. The rod is adjusted by means of the notches as shown in Fig. 160. The rod may be of metal with metal balls (Figs. 149 and 153), or of wood (Fig. 155). The metal rods used for the arms should be $\frac{3}{8}$ inch in diameter and 28 inches long over all. For the lower rod, which forms the hinges, the usual method is to get a $\frac{5}{16}$-inch rod, 24 or 26 inches long, and cut from each end a piece of the required length. The casting used on Fig. 149 is the regular curved brass sold by dealers. It is straightened by laying on a flat iron and striking a hard wood block held in the adjusting places. File flat surface smooth.

FIG. 159. *Large armchair*

The wooden rod is made the same as the cylinder. (Elementary Woodwork.) The ends are cubes with their corners cut off (Fig. 161). The back of Fig. 149 is also hinged to the rail, but the adjusting rod is held by a casting. The back of the chair (Fig. 153) is secured by two short rods passing through the legs and into the sides of the stiles near the bottom end. The upper end of the back is supported on the adjusting rod, which passes through holes in the narrow end of the arms. In Fig. 158 these rods are similarly placed except that they are cut short, so that their ends do not extend through to the outside of the legs or arms.

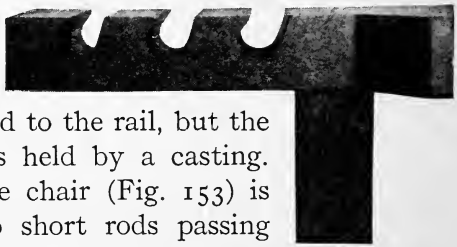


FIG. 160. *Adjusting notches*

The height of the legs may be varied to suit particular needs. If casters like those on Fig. 149 are to be used, the legs must be shorter than if no casters were to be used. If ball-bearing ball casters are used, they should be set up into the end of the leg so as to be scarcely visible. One-fourth inch projection will do.

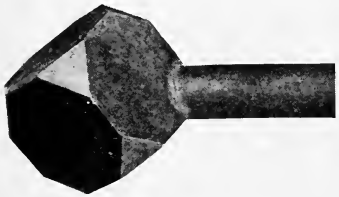


FIG. 161. *Cube on end of rod*

The thickness of the cushions should be considered also in planning the height of the rails and arms.

HALL SEAT

Directions for Making. This hall seat (Fig. 162) may be modified to correspond with the various styles of chairs. The vertical pieces may be omitted and the back rail raised. The band formed by the lower rails may be either straight as in this figure, or broken as in the chairs (Figs. 147 and 153). The

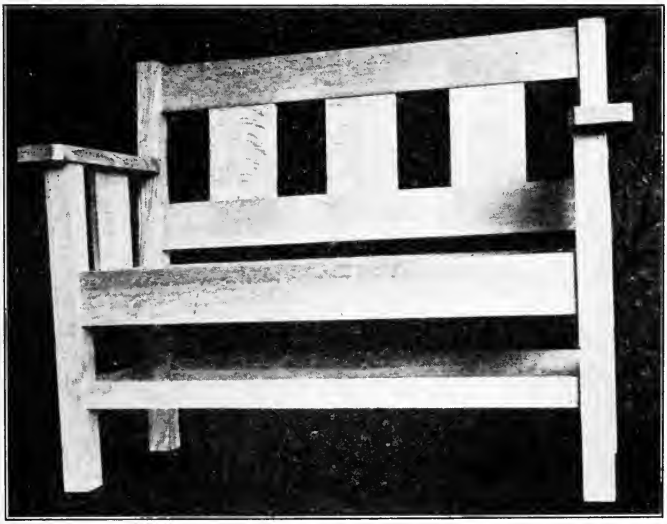


FIG. 162. *Hall seat*

size of stock may be heavier than in the chairs as in the drawing, or of the same size. The legs may be rectangular as in the armchair (Fig. 155). The seat may be of soft wood, but will look better if made of the same wood as the other parts of the piece.

In doing this work, follow the general directions in Part I. Read also what is said in regard to making chairs. The back should be the first part to be glued together, following the methods of clamping shown in Fig. 76. Test it in every possible way. Some of the tests are indicated in Figs. 66, 67, and 68. It is essential that such large pieces rest firmly while the glue is drying or they may change shape. The front is clamped, as shown in Fig. 64.

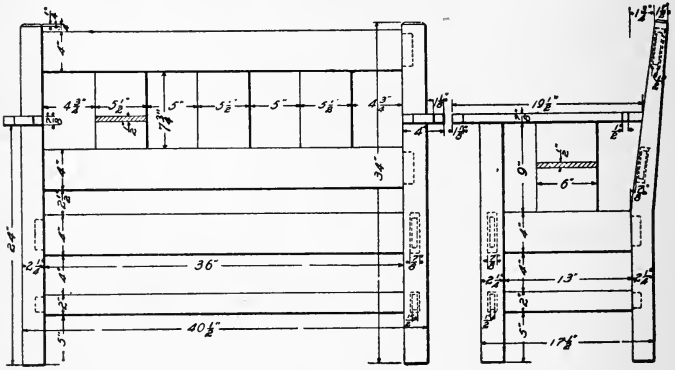


FIG. 163. *Hall seat*

As these pieces are large and long, even a very small variation at a joint may do considerable harm; therefore, test every corner and angle carefully. Looking for wind or twist (Figs. 69 and 70) is also very important. If the steel square is not long enough to use in looking for wind, make two straight edges. Be sure that they are straight and their edges parallel and look toward the light.

Clamping. In Fig. 164 is shown how to clamp front and back together. Notice the clamp that has been placed diagonally across the seat. This is to pull the corners square; this clamp usually requires but a very little tightening. Notice that the clamps on one end are not horizontal. This is to bring the vertical joints at the end square and the piece out of wind.

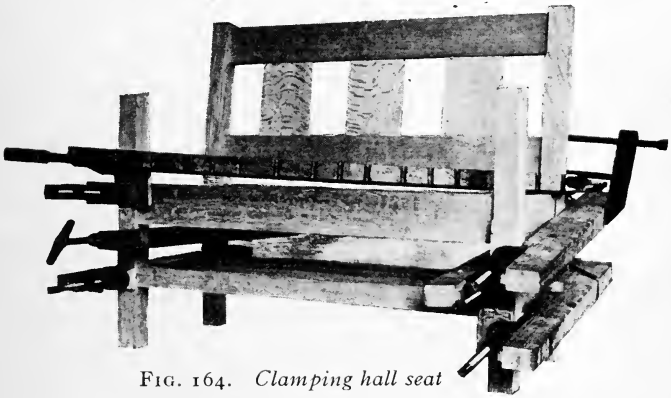


FIG. 164. *Clamping hall seat*

The arms are doweled both at the back end and on to the top of the front legs. Two $\frac{3}{8}$-inch dowels should be placed at each joint. The clamping of arms to place will require patience and care. Fig. 165 shows how this is accomplished. If you lack clamps for securing the arms in this manner, they may be held by screws. Drive these into the front leg from the top, and into the back end of arm through the back leg. Use flat headed screws covered with plugs dressed flush with the surfaces.

The Seat. The seat should be carefully fitted and put in place from below. To do this, fasten the cleats, upon which the edges of the seat are to rest, and then put the seat in position. After the seat is placed in position, glue and nail the end cleats in place.

A box may also be constructed beneath the seat, and the seat hinged to the back rail.

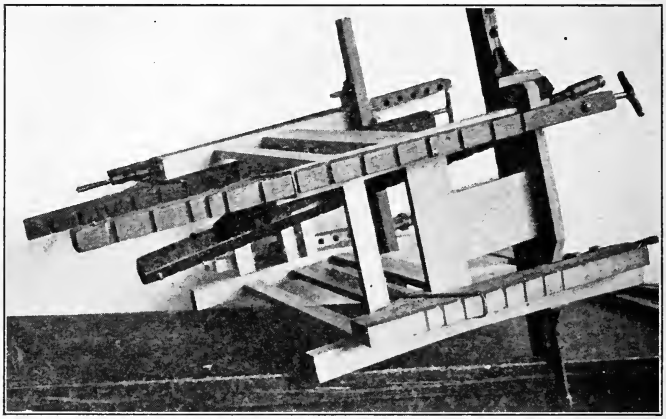


FIG. 165. *Clamping arms of hall seat*

If the top end rails are made thick enough to be even with the lower end rails on the outside, and flush with the inside edge of the legs, the seat can be put in place by shoving it in from the front over the front rail. It may then rest on the cleats without being fastened and may be removed at any time. Yet another plan is, to put a cross rail from front to back at the center, and make the seat in two parts.

TABLES

Drawing Table. The only difficult part of the work in making this table (Figs. 166 and 167) is the joining of the strips for the top. If you want a nice top, make it of strips of pine not over two inches wide. The proper methods of jointing and gluing are described under the topic of "Glue Joints." Study carefully all that is said under that heading before attempting to make the top for the table.

FIG. 166. *Drawing table*

The sizes given in the drawing (Fig. 168) are for a light table, which can be taken apart and packed in a trunk. If a more rigid table is desired, the parts may be made heavier.

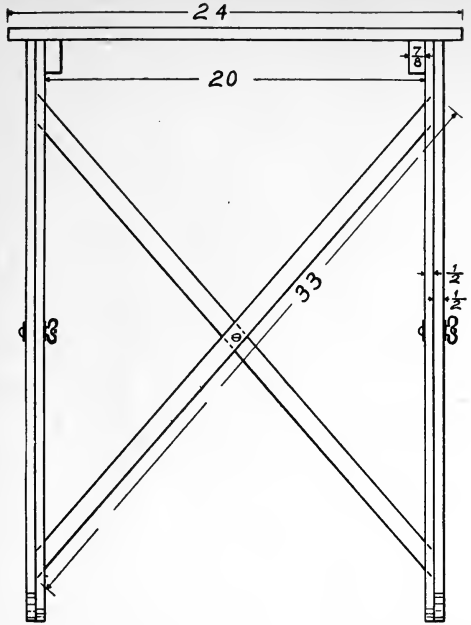
A table of the sizes given in the drawing should be sufficiently rigid for ordinary home drafting.

First make the top and finish it with one light coat of shellac. When the shellac has thoroughly dried, sandpaper it to a smooth surface. The top should be true in every particular—out of wind, edges all straight, and corners square.

The cleats should be straight-grained and well seasoned, and of the same width as the legs. The ends may be beveled and chamfered. Bore holes with an auger bit to allow the screw heads to sink about halfway through the cleats. The hole for the shank of the screw should always be large enough to let the screw go through easily. The point of the screw should extend nearly through the top.

FIG. 167. *Drawing table*

The small blocks at one end of each cleat should be of the same thickness as the legs. They should be glued and nailed with four wire nails in each block. These blocks must be placed on the outside of the cleats and at their back ends. The cleats are not interchangeable. The legs are also in pairs. The ends should be rounded with a chisel, using the shearing cut (Fig. 85). The slots may be worked the same as a mortise by lining with the gauge, boring holes, and finishing with a chisel. Another way is to start a hole at one end of each slot, saw down each side, and finish with a chisel. The sawing may be started with a compass saw (Fig. 169). As soon as there is room for the point of a ripsaw to enter the kerf, it should be used.



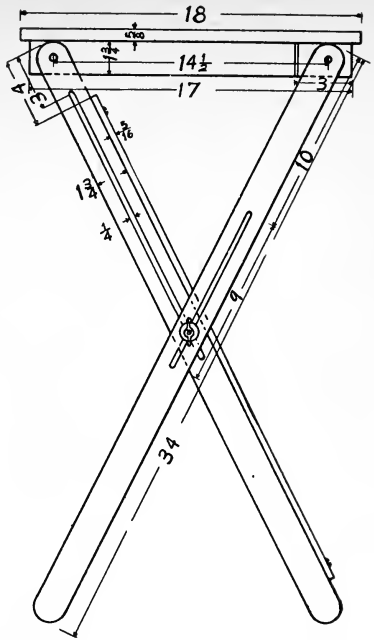


FIG. 168. *Drawing table*

The holes in the top ends of the legs for the hinge screws should be carefully bored and countersunk.

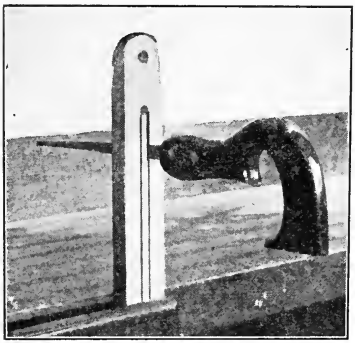


FIG. 169. *Sawing slot in leg*

The braces should be bent so that they will not throw the legs into wind. Their location on the legs is immaterial. The usual mistake in making the braces is in getting them too heavy. The bolts may be ordinary machine screws with common wing thumb nuts. The washers you will have to make, for those on sale have too small an outside diameter for the size of the hole. The lower part of the table may be given any finish. By making the top 20 inches by 36 inches and $\frac{1}{2}$ inch thick, and the legs 32 inches long by 2 inches by $\frac{1}{2}$ inch, you have a fine sewing table (Fig. 170). A top, 24 inches by 36 inches, requires legs $\frac{1}{2}$ inch by 2 inches by 36 inches.

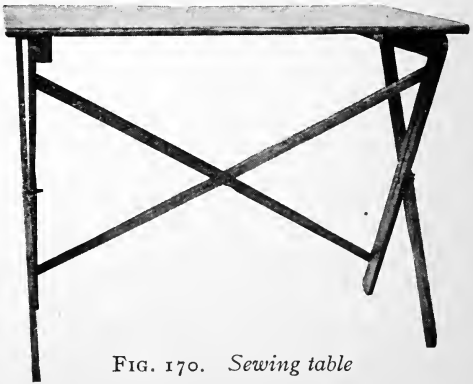


FIG. 170. *Sewing table*

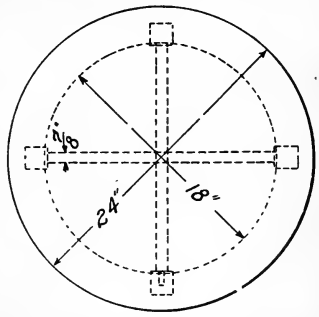
Before attempting to make any table, go over all of the designs and study their chief features. Note variations in height, width, and length; also sizes of stock used. Consider the various methods of joining the parts. After studying all of these designs, begin your own design by deciding whether your table is to be round or rectangular. Next, if it is to be a light table or one more substantial. This should be determined by its use and, partly, by the place it is to occupy. Determine if any of the parts are to be turned, or all left rectangular or square. Following this is the determining of the patterns for each part. Turned parts must be carefully planed to make sure that joints will be at flat surfaces, and also have material enough for strength. In laying out the joints it is a good plan to look out for surface enough to furnish suitable working faces, and proper bearings for the try-square. If no turning is used, you yet need to look out for the joints. Tapered legs, if tapered the whole length, add much to the work and care in making the joints. Whether the joints should be doweled or made by mortises and tenons must be decided, and should be shown in the drawing. The sizes of legs and rails may determine this matter. In planning your table, decide which kind of wood to use in each part, the kind of finish, and what hardware to use, if any. The legs may be made long enough not to use casters; cut off, if casters are wanted. Plan every item and then make a complete working drawing.

Round Top Table. The top for this table (Fig. 171) should not be less than $1\frac{1}{4}$ inches thick nor more than 24 inches in diameter. The better way to make it is by gluing together at least four pieces. These pieces should be carefully selected in order to avoid warping. Of course, all parts should be thoroughly seasoned and kiln-dried. Read what is said on page 57 about the making of glue joints and follow the directions, for this top will not be durable unless properly made.

After the glue has become thoroughly dry, dress one side of the top straight and out of wind. Next reduce the piece to an even thickness by gauging all four edges and planing down to the gauge lines. After it has been worked to an even thickness, glue a block to the center of the top or face side and strike a circle by which to work the outer edge (Fig. 96). This circle may be sawed with a compass saw (Fig. 97) or roughed out with a drawshave (Fig. 173).

FIG. 171. *Round top table*

In either case, it will require smoothing with a plane (Fig. 174). An iron smooth plane is undoubtedly the best tool for use in smoothing such a surface. The spokeshave does not give as good results, is more difficult to use, and requires more time. In no case use a file on such an edge.



In testing the edge be very careful to keep the head of the square always pointing toward the center of the circle (Fig. 100).

After the edge has been planed smooth, it should be sandpapered. At first use No. 1½ sandpaper on a block, using the edge of the block (Fig. 175). This block is held on edge to avoid rounding the edges of the top. Following the block, the paper should be used over the thumbs (Fig. 176). The surface is finished in the same manner as are those of rectangular tops (page 79).

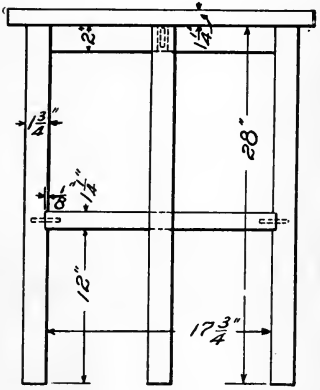


FIG. 172. *Round top table*

The shelf is made in the same way as the top. As there are no crosspieces under the shelf, special

care must be taken to have it so well made and of such material that it will not warp, twist, or check.

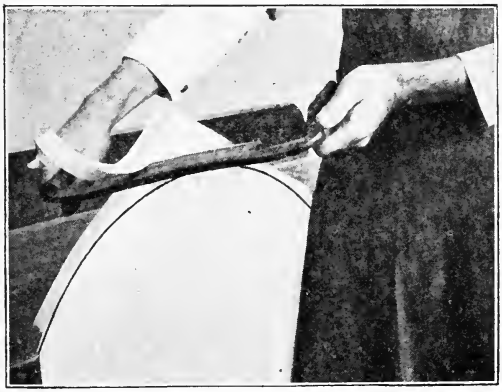


FIG. 173. *Using drawshave*

The legs are worked in the ordinary manner. The mortises must be just in the center of the legs, and the tenons exactly in the center of the crosspieces. In most work it is not necessary to have the mortises in the center of the legs; and in such cases it is a waste of time and a sign of poor workmanship to fuss about so locating them. But here the pieces are so located that both sides of the legs show alike, and therefore the mortises must be at the center. This is also necessary in order to bring the various parts into proper line. To locate the mortise at the center, find the center of each leg by measuring with the rule, then measure half the width of the mortise or tenon each side of the center and set the gauge to these marks.

Determine the point at which to bore the hole for the dowel, and bore it before working the gain.

Be very careful to have the hole exactly in the center, and just as far from the upper edge of the gain as the space at which you set the gauge for gauging at the edge of the shelf.

Any variation in these holes will throw the legs out of square, and this will be extremely difficult to remedy. Therefore, be very particular about every line. Before marking the width for the gain in the leg into which the edge of the shelf fits, measure the thickness of the shelf and, if necessary, change the dimensions to correspond with the shelf.

The shelf being round, requires a gain deeper at the center than at the edges, and this must not be overlooked. To determine the amount of this variation, draw a short arc of a circle on a piece of waste material, and draft the width of the leg and the depth of the gain at the center and at the edges. Draw gauge lines of the proper depth at the edges and work the gain; measuring the depth at the center as the work proceeds.

FIG. 174. *Planing a circle*

When the crosspieces to support the top are made and the halved joint finished, the ends are laid off by clamping the two pieces together and adjusting them to the gain at the center. Find the exact center, and measure equal distances each way; then draw lines for the inside ends of the tenons, the same as in laying off tenons for chairs (Fig. 11).

FIG. 175. *Sandpapering edge*

Before making the lines for the inside ends of the the tenons examine the shelf carefully, and if it varies in size from the drawing, cut the tenons to match the shelf. Notice that the shelf is let into the legs $\frac{3}{16}$ of an inch at the center of the leg, and therefore the total length of the crosspieces between the tenons is $\frac{3}{8}$ inch less than the diameter of the shelf. After determining the inside lines for the tenons, locate the center of the edge

and measure each way for the width of the tenon. Compare the lines as shown in Fig. 8, and if correct, draw gauge lines on both edges and ends. Set the gauge so as to draw all the lines from the face side. Compare all the lines before working the tenons.

After the tenons have been worked, glue crosspieces together, clamp them in position on the shelf so that each end will be exactly opposite the dowel hole in the shelf. Glue the dowels into the legs and when the joint in the crosspieces is dry, glue the frame and shelf together. Secure the top, as shown in Fig. 82.

This table may be modified by changing the sizes or by making the top or shelf square. With a square shelf, it is similar to the taboret (Fig. 110).

If the legs are extended through the top, it is made similar to Fig. 94 or Fig. 177.

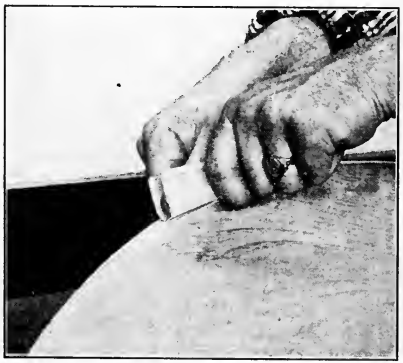


FIG. 176. *Sandpapering edge*

Any of these styles of tables may have turned legs. Turned cross rails may also be used. The patterns for the turned parts may be similar to those shown in Figs. 182, 186, or 238. Several of the designs in "Elementary Turning" may readily suggest patterns for table legs or rails

Leather Top Table. As the top of Fig. 177 is to be covered with leather, it may be of soft wood.

FIG. 177. *Leather top table*

Although this style of table is usually made as large, or larger, than the dimensions given in the drawing (Fig. 178), it may be made of the same size or smaller than Fig. 171.

The thickness of the top should be proportioned to the width, as the strength of the top has much to do with keeping the table in good shape. The crosspieces should be halved at the center and tenoned into the legs. The top and the shelf are made in the same manner as those used in Fig. 171. They should be secured to the crosspieces as shown in Fig. 82. The two pairs of crosspieces should be exactly alike. If one is secured to the other as the glue at the halved joint dries, it will help to make them alike.

The top should be clamped against the ends of the legs, and the notches for the ends of the legs

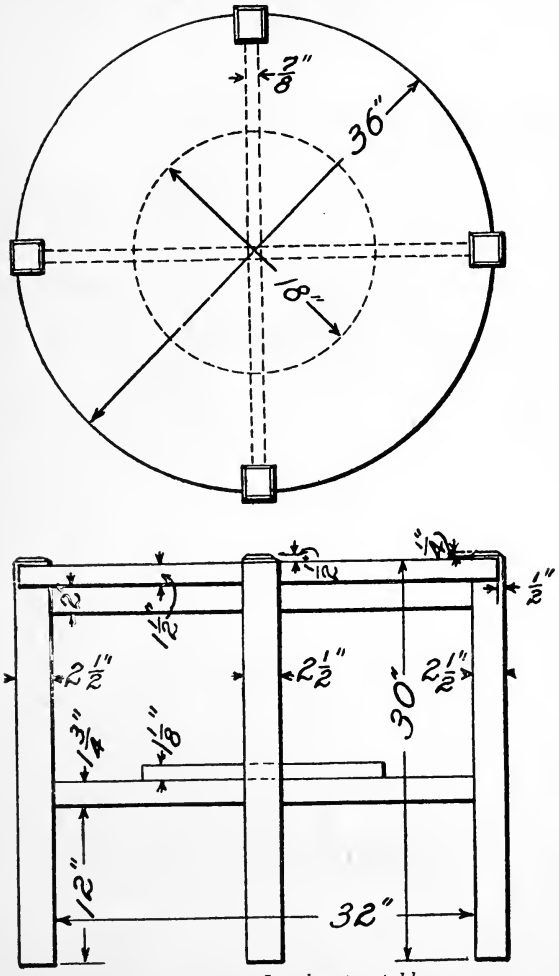


FIG. 178. *Leather top table*

marked by scribing around them, the same as for the seat of the chair (Fig. 130). The chamfering of the top end of the legs should not be done until after the notches in the top have been marked. The lines for the notches may be carried around the edge (Fig. 103). Be sure to mark the top so that it may be returned to the same position. This table may be modified by making the top and shelf octagonal, hexagonal, square, or rectangular. The legs may be doweled to the underside of the top, the same as in Fig. 110. For this size table, two dowels should be used in the top of each leg (Fig. 152).

FIG. 179. *Light table*

This is a good style for a polished hard wood top. If the table is to be polished, all the parts should be fitted and then the top and shelf removed and polished before the final fastening together.

In Fig. 177 is shown the table with top prepared for a leather covering. The leather should be carefully stretched and fastened around the edge with large headed nails, similar to those shown in Fig. 137.

Light Table. There is very little about this table (Fig. 179) that is difficult to make except the glue joints in the top, and these should be made with all possible care (page 57). As the legs are long and the tenons on the rails short and narrow, it is essential that the joints at the corners be quite perfect. The directions for making mortises and tenons, glue joints, legs, etc., apply to tables as well as to chairs and other pieces, and cover substantially all the information required except that of making and fitting the drawer.

If the legs are to be tapered, the taper should not include the parts which contain the mortises and the parts against which the rails are fitted.

If a drawer is to be used, the rails are glued together as shown in Fig. 180. This framework may be joined either by dowels or by mortises and tenons. When the legs are clamped to the front and back rails, there should be a piece in the drawer opening as shown in Fig. 185.

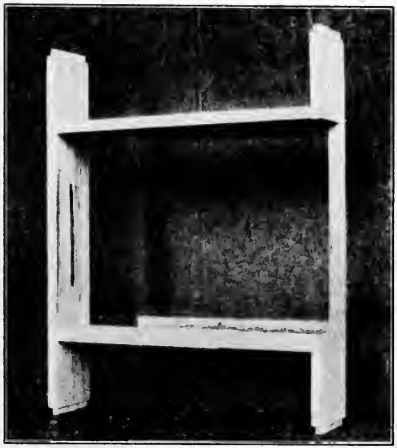


FIG 180. *Rails and drawer runners*

Be very particular to make this frame square, or the drawer will not work properly. Read the directions for tapering legs (page 37), for fastening tops to frames (page 96), and also for clamping and finishing. If the table is to contain a drawer, read what is said about making drawers (page 53).

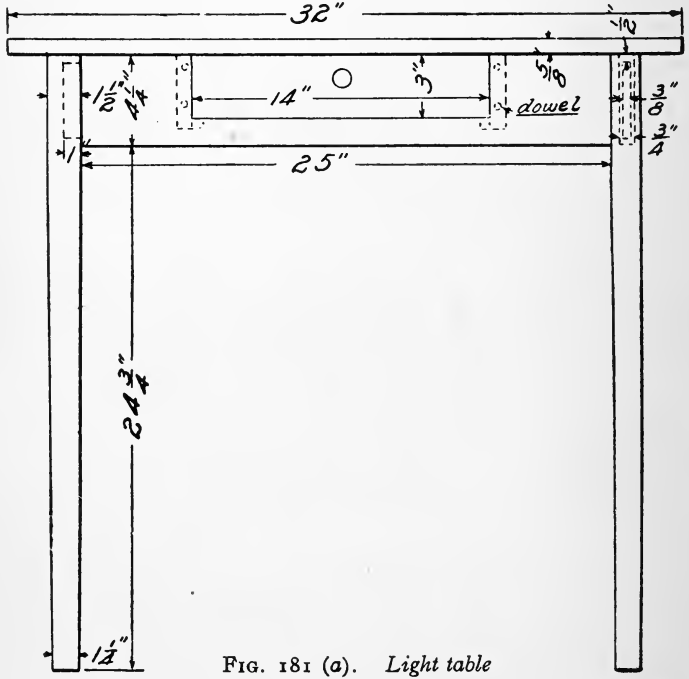


FIG. 181 (*a*). *Light table*

This table may be modified by using turned legs; by omitting the drawer; by making the top heavier, or by tapering the legs to 1 inch square at the bottom.

If the legs are to be turned, the top should be smaller or the stock for the legs larger. The difficulty in making light tables is to make them strong enough where the rails and legs join. The difficulty is much less if rails are used near the bottom of the legs, as where there is a shelf, although rails are used without shelves. If the legs are light use dowels at the ends of the rails, and strengthen the joint by using strong glue blocks on the inside corners.

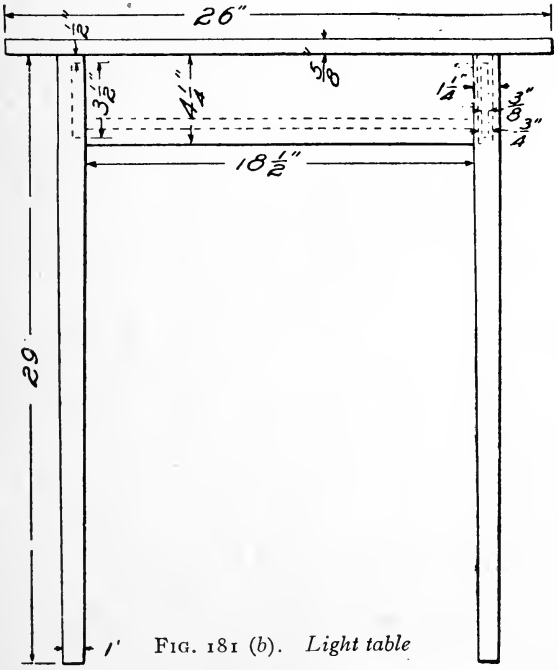


FIG. 181 (*b*). *Light table*

Library Tables. This table (Fig. 182) may be made either with or without the drawer. For many uses a smaller top would be better. The dimensions of Fig. 182 are given in Fig. 183.

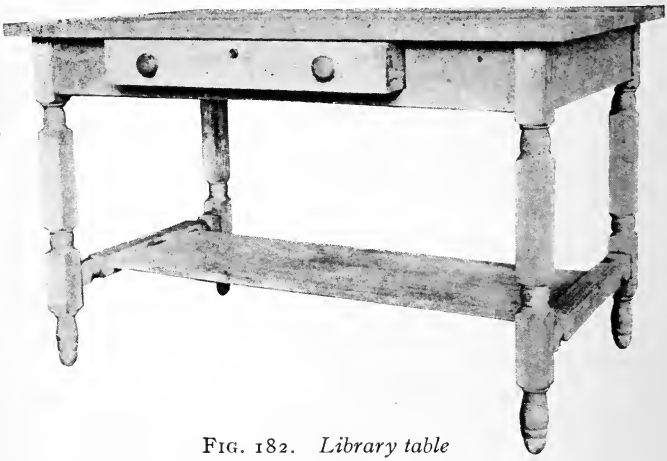


FIG. 182. *Library table*

If it is necessary to match other pieces of furniture, all the parts may be of heavier material. The turning may be omitted, or the legs may be turned their entire length except at the joints. The middle portion may be cornered in the lathe and dressed to an octagon with a smooth plane. As is usual with tables, the table top is the difficult part to make. Read all about "Glue Joints," page 57, before beginning work on it. The framework is made in the same manner as that for an ordinary footstool. The parts of the ends are first glued together, and

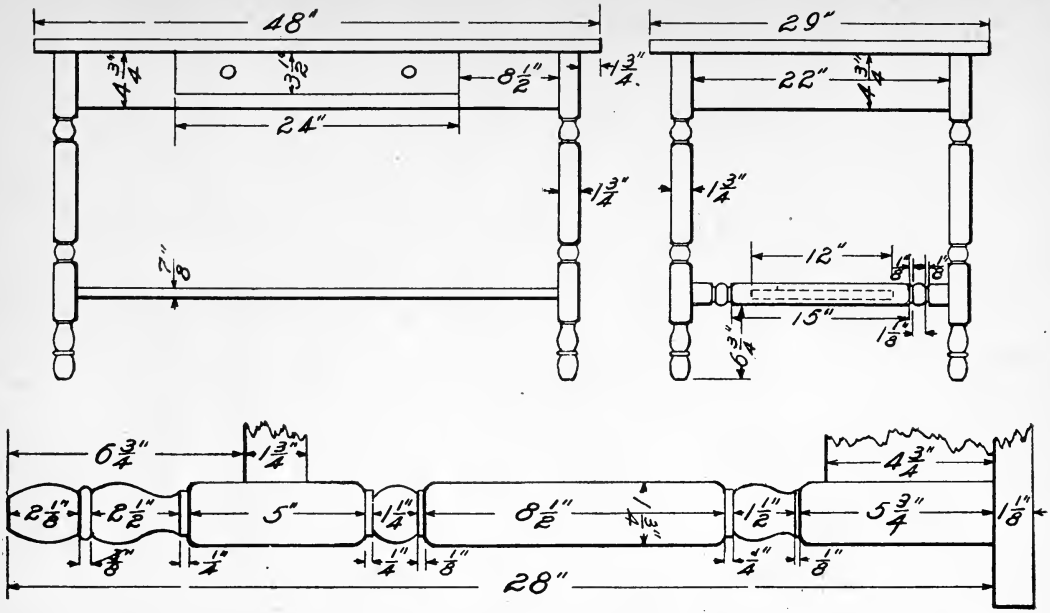


FIG. 183. *Library table*

then the long side pieces and shelf are glued into place. Be careful to glue the pieces straight and square. Examine the end for wind as shown in Fig. 184.

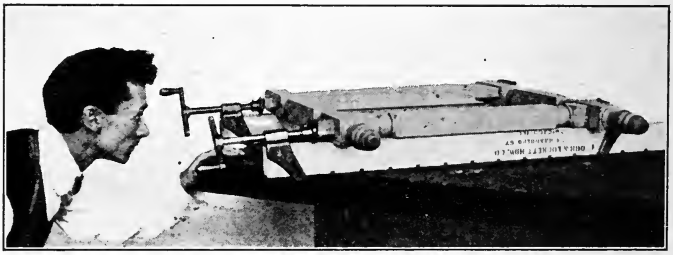


FIG. 184. *Sighting for wind*

Place the steel square and try-square as shown in Figs. 67 and 68. If the table is to have a drawer, the sides and rails are glued together before the ends are attached, as shown in Fig. 180.

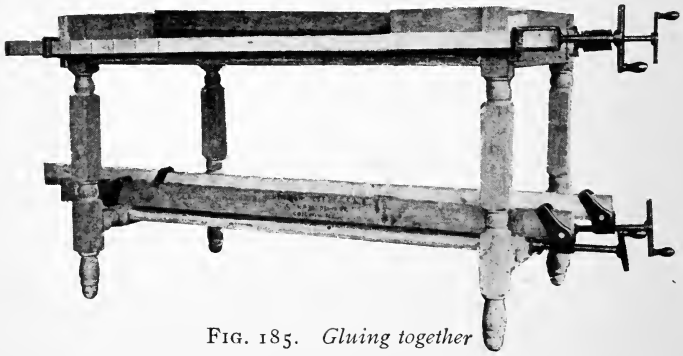


FIG. 185. *Gluing together*

In gluing the whole together place a temporary piece in the drawer openings as shown in Fig. 185.

The drawer should be made as directed on page 53. As this is a large drawer, more care will be required in making it. The joints at the corners should be dovetails. The front joint should be half blind, and the back corners common open dovetails.

This table (Fig. 186) is similar to Fig. 182 without the drawer. Read the instructions given for

FIG. 186. *Library table*

making Figs. 179 and 182, as they apply quite closely to the work on Fig. 186. The turning on this table is not so difficult as that on Fig. 183, and may be dispensed with entirely.

The shelf rests on the top of the lower rails, avoiding the joints at the ends of the shelf. The

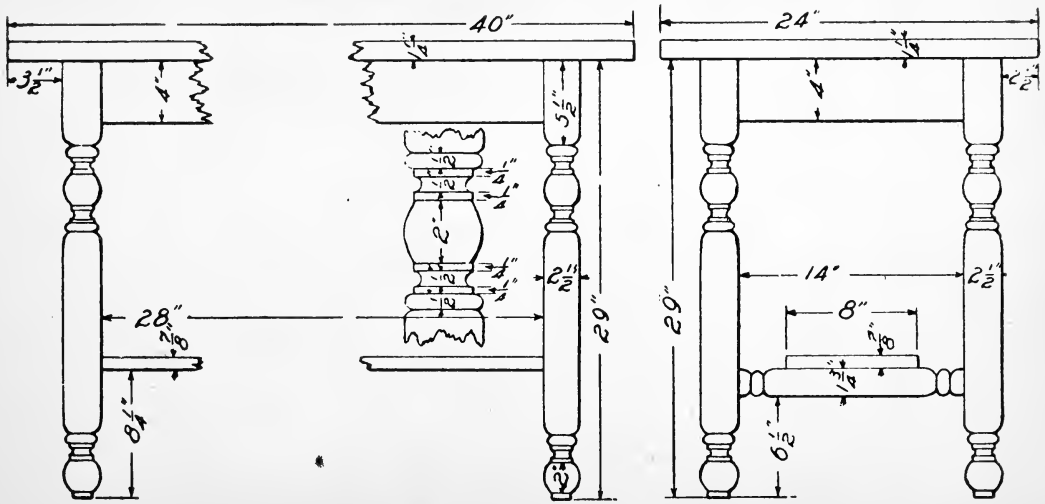


FIG. 187. *Library table*

shelf and cross rails beneath the shelf may be omitted. If these parts are not used, the joints at the upper end of the legs must bear all the strain. Unless there is a shelf, the legs should be tapered (Fig. 179). Legs turned the entire length below the rails may be used on such tables. As turned legs from the same size stock do not appear as large as square legs, either the top should be lighter or the stock for the legs larger, if the legs are to be turned.

FIG. 188. *Library table*

This library table (Fig. 188) is designed to be finished either by oiling or by varnishing and polishing. Instead of the keyed construction and screws, the parts may be glued. Study the design carefully and then make a design of your own.

In making the top, read the directions given for glue joints, cross planing, veneering end grain, finishing, and polishing. The legs shown are hollow, being made of $\frac{7}{8}$-inch stock. The inside surface of one piece should be carefully trued, and two pieces fitted to this side. Nails should be driven at the inside corner so that the pieces may be kept in position while clamping, and then the parts separated and the glue applied. After two pieces have been glued to one side piece (Fig. 189), their edges should be jointed and dressed to width and the inside surface of the other piece fitted and glued. The pieces should be carefully clamped, so that they will be square and of proper size.

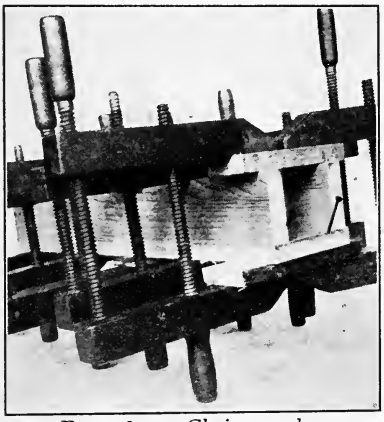


FIG. 189. *Gluing up legs*

The tenons and mortises are laid out and worked in the same manner as described under these topics, except that because the legs are tapered, either a tee bevel or a try-square, with a tapered piece against the head, must be used.

The tapered pieces (Figs. 22 and 23) are better than a tee bevel and should be used by all who have **not** had much experience in lining.

The end rails may be either tenoned or doweled. The latter is probably the better method for hollow legs. For legs of this size, four dowels should be used in each end of pieces 4 or 5 inches wide.

The drawings (Figs. 190 *a*, *b*, *c*, *d*) show the parts as used in Fig. 188. This design may be modified by omitting the shelf and lower cross rails, the drawers, and the sliding shelves. If no drawers are used there should be only one rail at each side.

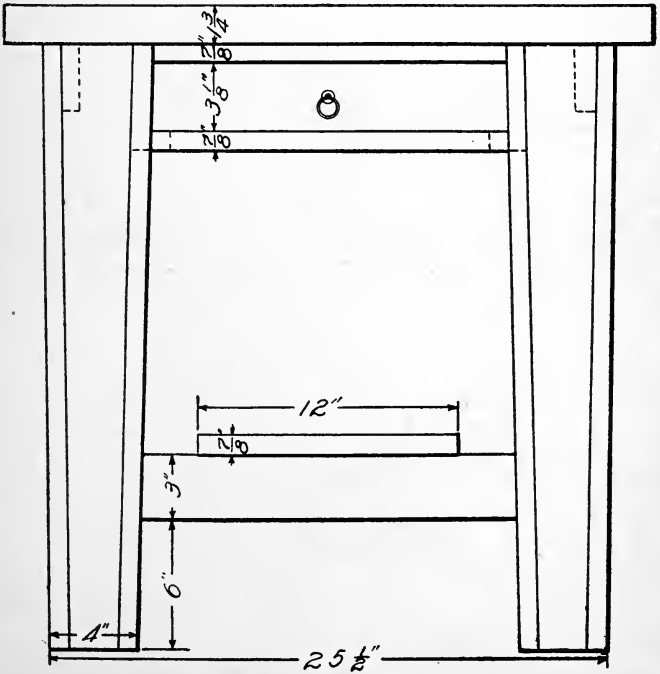


FIG. 190 (*a*). *Library table*

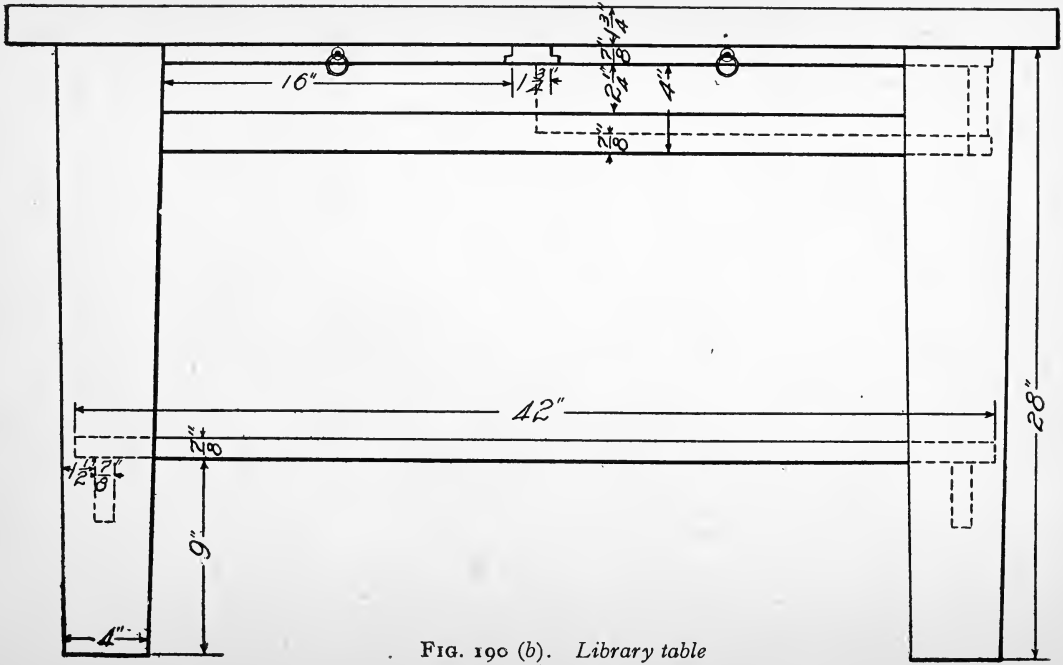


FIG. 190 (*b*). *Library table*

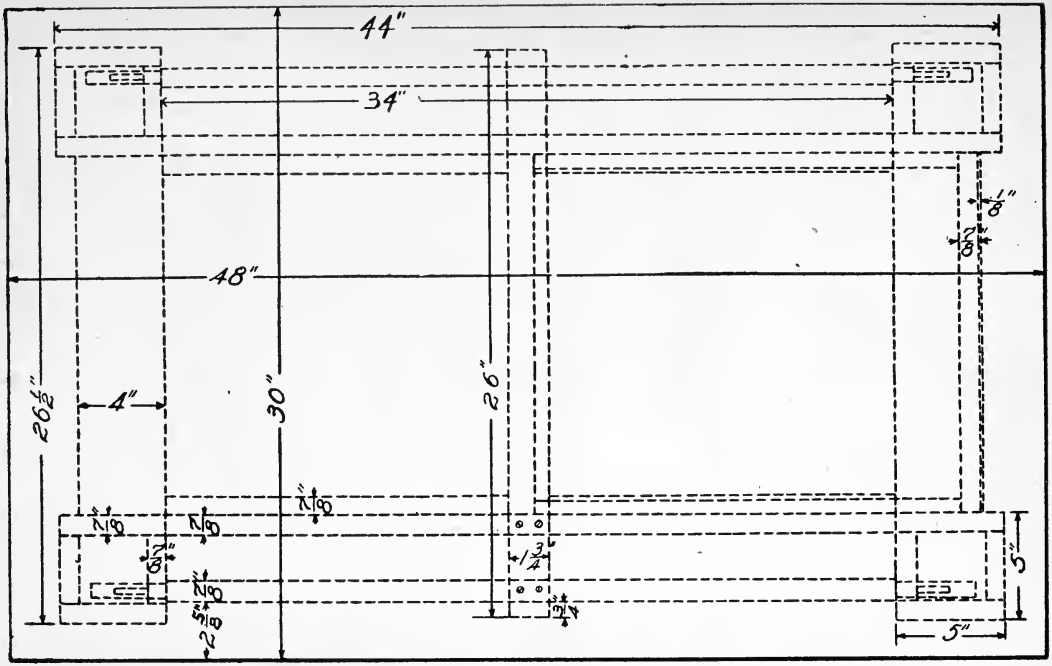


FIG. 190 (*c*). *Library table*

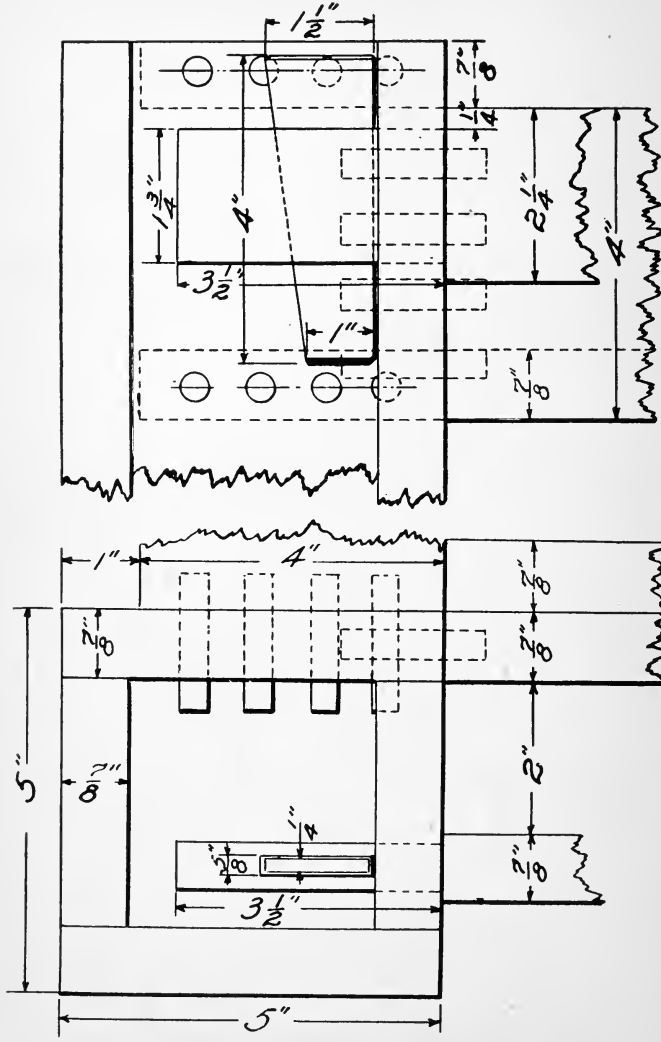


FIG. 190 (d). *Library table*

Large turned legs may be used in the same way as the columns in the piano bench (Figs. 193 and 194), or may extend to the floor. The drawer may be at the side instead of at the end. Such an arrangement would require a frame similar to Fig. 180.

The top may be made of $\frac{7}{8}$-inch stock and a facing used the same as on the taboret top (Fig. 92). Such a top may be made thick enough to be used without rails at the top of the legs. The legs, in this case, would be secured to the top first by fastening pieces to the tops of the legs, and then by securing the pieces to the table top (Fig. 93). If casters are used on such tables, they should be set up into the bottom of the legs, so that they will not be visible. Use ball bearing ball casters in such places.

A careful study of this design will provide much material for use in designing tables or stands of various sizes. By using solid legs, 4 inches at the top and 3 inches at the bottom and plain rails 4 inches wide, you can make a table which will be very substantial and require less than half the time which would be required to make that shown in Fig. 188. The shelf may be omitted. In designing such large tables be very careful about the sizes. Measure the tables you have in your home, and you will get information of much value in making your design. Notice the difference in weight of different styled tables, for this is an important element in the design, especially of tables for library use.

PIANO BENCH

A Plain Design. As this bench (Fig. 191) is a plain design, it is essential that the wood be selected with care. As the top is liable to warp unless made of several pieces, it should be made in very much the same manner as a table top. Sometimes a piece can be selected which is wide and yet not likely to warp. Pieces cut from near the center of the log so that they are fully quarter-sawed, are often of this nature (Figs. 44 and 45).

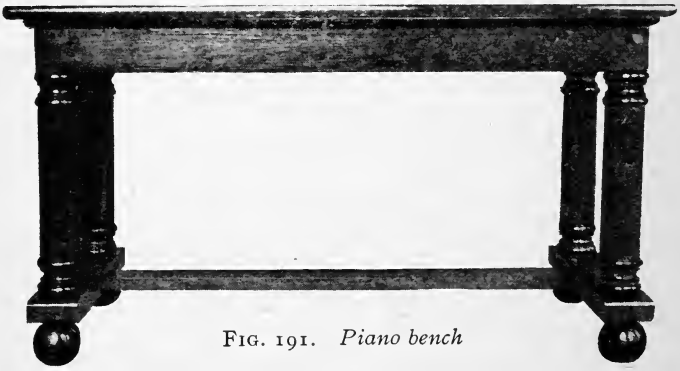


FIG. 191. *Piano bench*

This is not quite as necessary when using plain mahogany as when using oak. In factories, such pieces are often glued up of thin stock and then covered with veneering. Such a method is not deemed advisable for the high-school pupil, although, if properly done it will make a better top. The drawing (Fig. 192) gives the sizes of the parts.

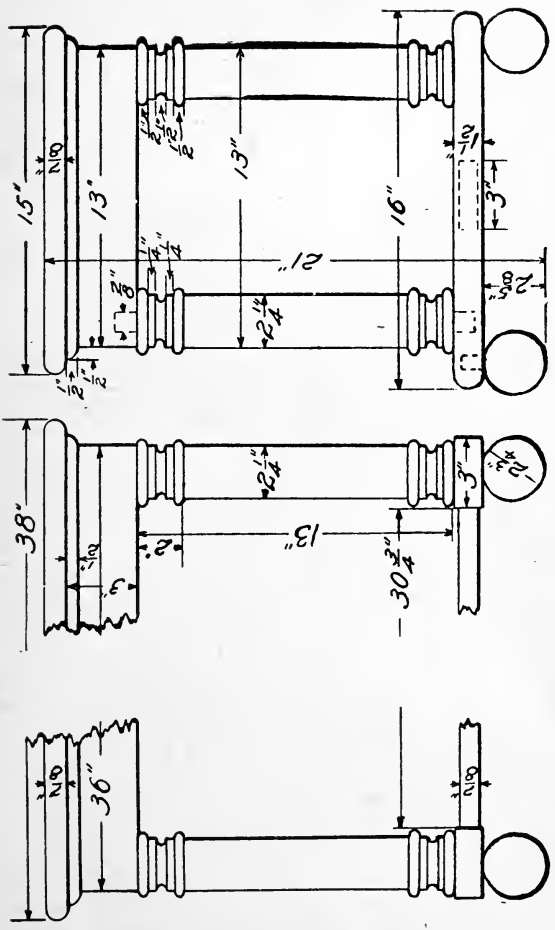


FIG. 192. *Piano bench*

FIG. 193. *Corner of piano bench*

Columns. The columns should be of carefully selected stock. There is no need to allow any extra length for a stub at either end, for the ends will be simply $\frac{7}{8}$-inch round tenons, which will be entirely covered, and therefore, it is not necessary to cut off the marks made by the lathe centers.

There are many possible patterns for columns. The designs given in Figs. 191, 193, and 194 may be copied or used as suggestions, or the columns may be square, as in the taboret (Fig. 90).

In making such columns it is necessary that all four be alike. In order to get them all exactly the same pattern, be very systematic in your methods of work.

After the piece is in the lathe, first round it the entire length, using only the roughing gouge. Caliper and smooth each end enough for the beads or other pattern. Measure the length between the tenons and cut down with skew chisel and gouge to nearly the size of the tenon. Do not use a parting tool for cutting at the ends, as it cuts too roughly for such use. Use the sizing tool (Elementary Turning) and finish the tenon. Lay

out each end and turn the pattern. Turn the cylindrical portion and then remove the column from the lathe. Turn all of the columns in this manner. Place them side by side and compare. If all are alike, sandpaper them ready for the stain or finish.

Be sure to keep the center marks on each end so that the pieces may be returned to the lathe at any time. You may find it a good plan to fill and rub the pieces in the lathe, and even return them to the lathe for applying and rubbing the various coats of varnish. It is not likely that you will wish to polish them with shellac, as it will require too much time to give a similar finish to the top and other flat surfaces by hand. Several coats of varnish may be used, which should be given a smooth polish, resembling piano finish.

FIG. 194. *Corner of piano bench*

Box. In making the box, the mitered corners are the difficult part of the work. If you have not made a mitered corner, make one according to instructions given in "Elementary Woodwork," before attempting to make the corners for the box. Be very particular about these corners, especially at the outer angle, and when you think they are all right, try

them in the clamps (Fig. 195). Do not forget to rabbet the place for the bottom before clamping the corners.

After you are sure that every joint fits properly, size the ends with thin glue. Allow the glue to dry, and then scrape all the surfaces perfectly smooth. Apply fresh glue and clamp as before. Brads may be used in each corner to prevent the pieces from slipping out of place while clamping. These should be driven where the molding will cover them.

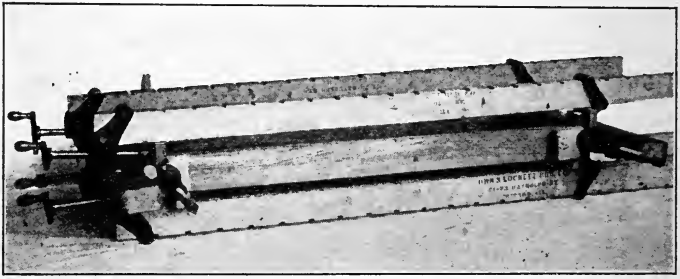


FIG. 195. *Box in clamps*

Be careful to have the box square in every way, and the clamps supported so that the box will not be in wind when the glue has set.

After removing the clamps fit the bottom to place and glue and nail at least one piece at each end of the box to keep it in shape. After the bottom is in place, dress the upper and lower edges of the box and all four sides, testing all for squareness, straightness, and wind. Plan to use as little of the material as you can in squaring the piece.

Glue Block. The joints at the corners may be strengthened by use of glue blocks. If such blocks are used, they should be triangular in form and very carefully fitted both to the sides and the bottom, and should be large enough to receive the dowel at the end of the column. They should be clamped in both directions (Fig. 196).

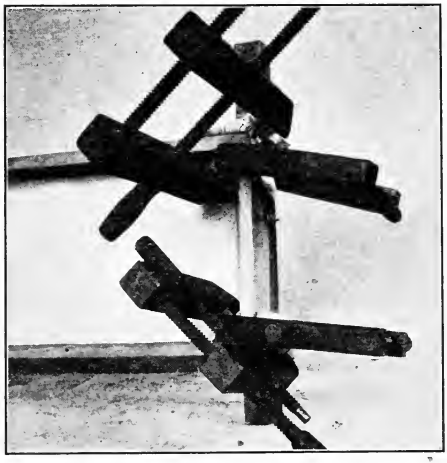


FIG. 196. *Clamping glue blocks*

Molding. The next step is making the molding strip. This is made by first squaring a piece and then rounding one corner with a plane. A block should be used under the sandpaper in smoothing the rounded edge. Be careful to keep the other edges sharp or they will show badly when the molding is in place.

Fit the miters, using a brad at each corner to hold the molding in place. Glue a side and an end at one time, clamping them as shown in Fig. 197.

After the box is finished you can then determine the location of the columns, and likewise the

length of the center rail. Should the box vary any in length from the size which is given in the drawing, place the columns in the same relative position at the corners and make the lower frame to correspond.

Rails. Locate the centers of the dowels on the bottom of the box and make the space between the cross rails such that their centers will exactly coincide with the centers of the dowels on the box.

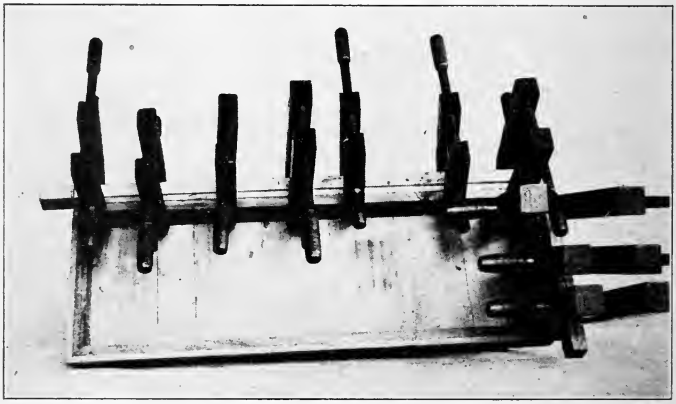


FIG. 197. *Clamping molding*

This gives the correct space between the tenons on the center rail.

Make the mortises and tenons and join the center rail and two cross rails, being extremely careful to keep all square and out of wind.

Find the center of each cross rail and measure each way, one-half the distance between the centers

on the bottom of the box. Where these lines cross the center of the width on the rail, bore holes for the tenons.

The balls should be located so that they will be even with, or a little beyond, the outer ends of the cross rails, and in the center of the width. The size of the balls may vary considerably from the drawing. In Figs. 191 and 192 they are the same diameter as the columns. In Fig. 193 their horizontal diameter is the same as the columns and their vertical diameter $\frac{1}{2}$ inch less. In Fig. 194 their horizontal diameter is $\frac{1}{2}$ inch greater than the columns and their vertical diameter $\frac{1}{2}$ inch less than the columns. Remember that in turning balls having large tenons, the actual height of the ball to the tenon is less than the true diameter.

FIG. 198. *Balls*

The balls should be turned from one piece (Fig. 198), and not cut apart until varnished and polished.

After all the parts are finished, the hinges should be set, as directed under the topic "Hinges," and the columns and balls glued in place. This gluing should be very carefully done as there is considerable strain on the joints.

A chain should be secured to the top and inside of the box to hinder the straining of the hinges.

MUSIC CABINET

The making of a music cabinet (Fig. 199) is quite fully described under the topic heads "Face Marks," "Mortises and Tenons," "Paneling," and "Hinges."

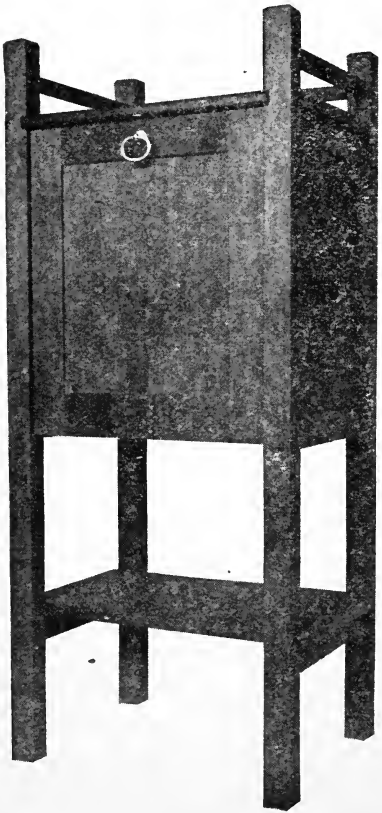


FIG. 199. *Music cabinet*

The sides (Figs. 201 and 202 *a*) are simply two pieces of paneling with the stiles extended both above and below the panel, and two additional rails. These sides may be planned to have other panels between the lower and middle rails.

The door is made the same as Fig. 208 or the panels in Part I. The back may be a board, as shown, or a paneled piece the same as the door.

Shelving. The shelving is most easily secured by fastening

pieces against the side panels might have been flush with the inside of the stiles (Fig. 35). In that case grooves would have been cut in the panel for the shelf ends before the panel was put in place.

The number of shelves (Fig. 200), as well as the length of the panels, may be varied to suit individual requirements. The top and the bottom shelves are simply straight boards fastened to the rails by screws. The top extends over the end of the door and is gained into the stiles to prevent it from warping. The back is held in its place by screws at the lower end and tongue and groove at the top. This arrangement will admit of the cabinet being taken entirely apart by removing the door, top, bottom, shelf, and back.

FIG. 201. *Side, inside view*

panels (Fig. 201). The made thicker and placed

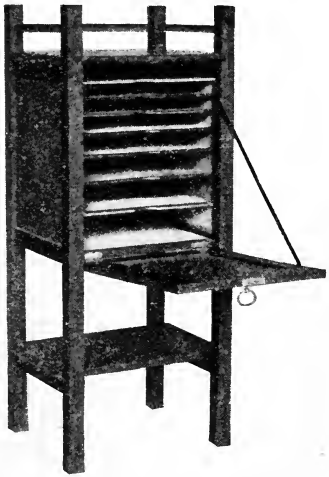


FIG. 200. *Cabinet—open*

This design not only supplies sufficient directions for making a variety of music cabinets, but also furnishes all necessary information for making a great variety of cabinets, toilet cases, and other pieces.

For the music cabinets, the simple modifications are the changing of the door to swing at the side, and

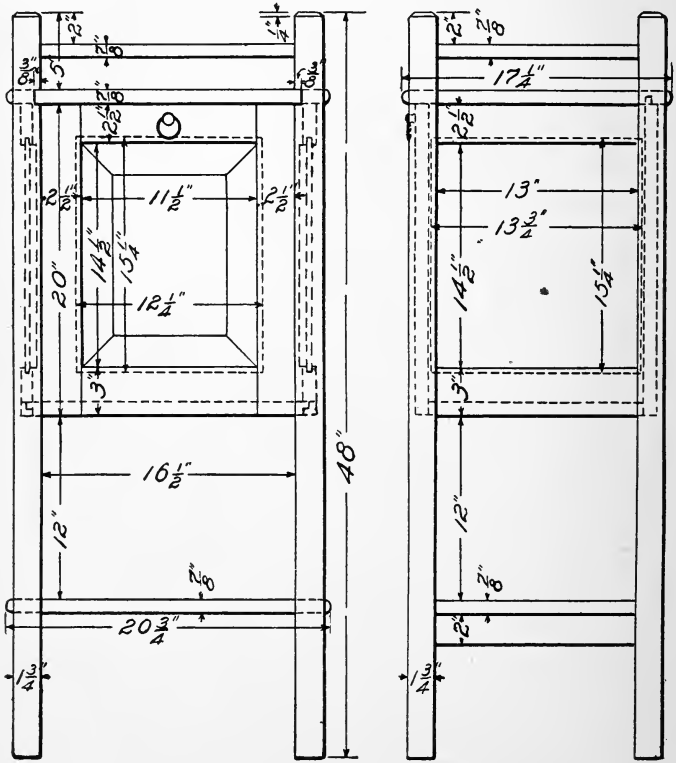


FIG. 202 (*a*). *Music cabinet*

the altering of the shelf arrangement. The height may be changed by omitting the open space below the shelves, or this space may be enclosed either with the one door or by using a second door. The interior can be arranged for other purposes without changing the outside, or you can retain only the plan of the outer frame, and build the entire project to suit your requirements. For this, you will have all the necessary information in the discussion of the project and in the general directions. In all of your plans keep to the panel style of sides and doors. You may be able to make a case by using wide boards in these places, but the use of such a design will not yield a proper return for your time. For some purposes the shelving or other interior arrangements are made in the same manner as the pigeon holes (Fig. 212), and then slid into place. This not only makes the assembling easier, but is a better form when there are vertical as well as horizontal partitions.

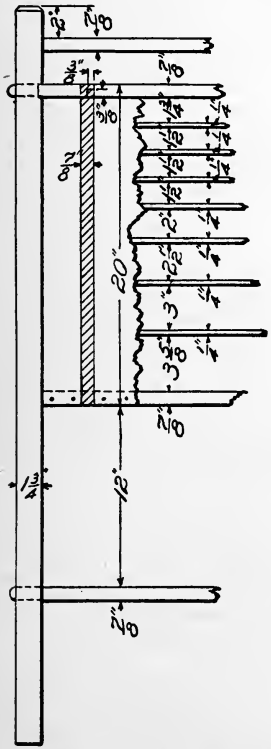


FIG. 202 (*b*). *Music cabinet*

CLOCK CASE

The making of a clock case follows very closely in principle the making of the music cabinet. The corner posts are longer, and need not be so far apart. The enclosed portion may be smaller, but ought to be paneled in the same manner. The front, instead of being a panel, may be a light door frame filled in with glass, and should also be hinged at the side instead of at the lower end.

Sometimes such large clocks are placed in open frames instead of in cases, the parts being nailed together or so placed as to require little more than rough workmanship. This makes a much more simple problem but is not satisfactory in the end, as such frames do not protect the works and it is difficult to keep them clean. Another matter of much importance is, that the making of a clock case will require considerable time, which will be spent for small returns, unless you make a case that has something in its construction that is worth learning.

The first step in making a large clock case is to select the works and find out just what size the case should be. The fall of the weights will govern the length of the posts.

When you have the data from which to get your sizes, make a complete working drawing. Follow the same general order in making the parts as directed in making the cabinet (Fig. 199). The clock may be enclosed the entire length or only about the works.

SHOE BOX AND COSTUMER

An excellent design to illustrate the various forms of ordinary paneling is shown in Figs. 203 and 204. The panels used are described at length in Part I under the topic head "Paneling." There is little to do in making this project aside from making the panels. The panels may be mitered together at all the corners, or the front panel may extend to the corner and be secured to the edge of the end panel in the same manner as the end panel is secured against the end of the back panel in Fig. 206.

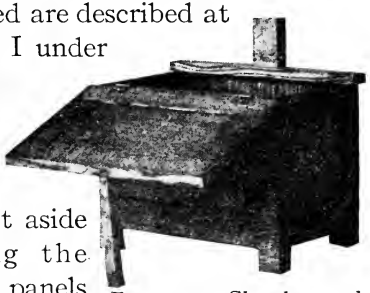


FIG. 203. *Shoe box and costumer*

The joints at the corner may be either glued or secured with round head blued screws. The style of hooks and their arrangement may be varied to suit individual requirements.

The panels may all be of one kind. If the back panel is a plain sunken panel, the pole should be long enough to be secured to the bottom cross rail, as well as to the top rail.

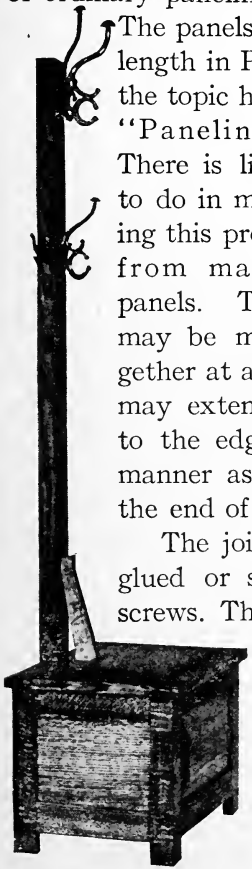


FIG. 204. *Shoe box and costumer*

Shoe-blacking Outfit. If the piece is intended for a shoe-blacking outfit, the cover may be hung as shown in Figs. 203 and 204, and supplied with a foot rest. If it is simply for a shoe box, the cover should be hung as shown in Fig. 205. In this case the ornamental brace, which supports the cover when open, is omitted.

Method of Making Pole. The method of making the pole is similar to the one used in making a tapered leg. The taper should extend only to the top of the box. The pole may be much lighter than the size given in Fig. 206.

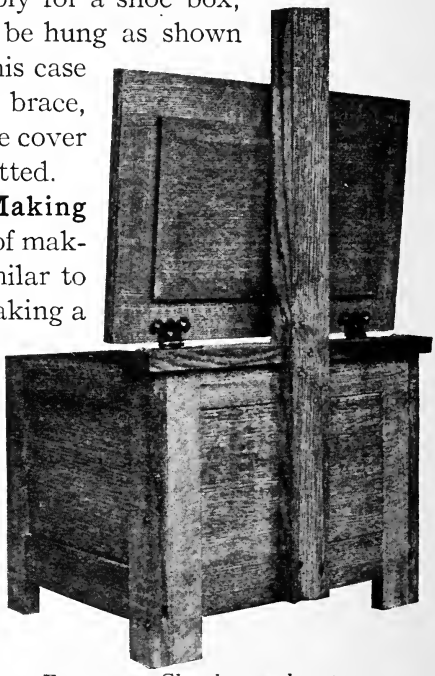


FIG. 205. *Shoe box and costumer*

Instead of securing the bottom of the box in a groove, it may be nailed and glued into a rabbet the same as the bottom of a piano bench (Fig. 192).

Chest. By omitting the pole and having the lid cover the entire top, this design can be made into a chest of any desired size.

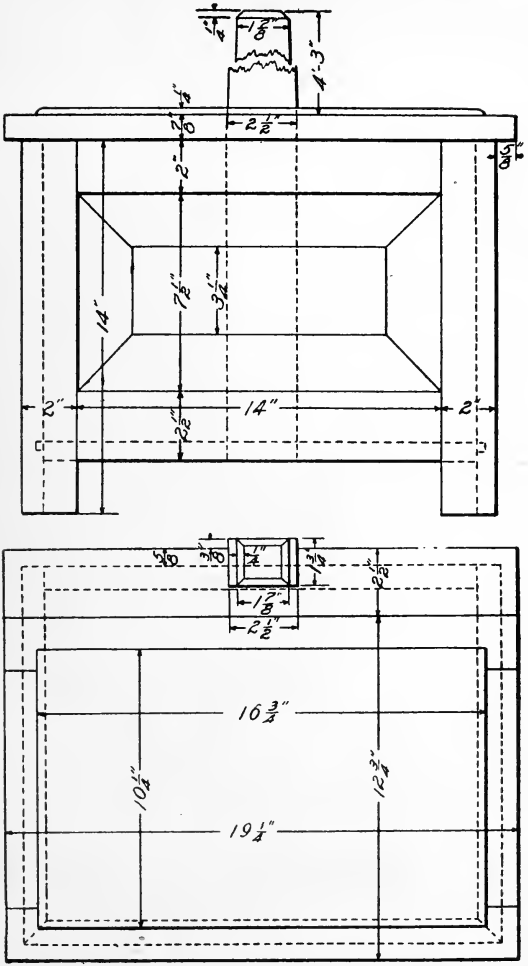


FIG. 206. *Shoe box and costumer*

In designing boxes or chests with paneled sides, the thickness of rails, stiles, and panels, should usually be the same as those in Fig. 206. For boxes much less in size, thinner stock may be used. The difficulty about using rails or stiles less than $\frac{7}{8}$ inch thick is, that the strength of the material at the sides of the groove will not be sufficient. When the width is less than $\frac{1}{4}$ inch, there will be places in which the strength depends almost entirely on the soft, porous, or weaker grain of the wood. This is because the annual growth is a somewhat definite quantity, and to get a proper amount of strength, the parts should be thick enough to include both kinds of grain. In woods like basswood this is not so important, as there is no marked difference in the grain. This is one reason why basswood and other close-grained woods are used for articles requiring thin stock. The width of the rails and stiles should increase with the size of the box. Usually, the bottom rail is wider than a stile, and the top rail the same width as a stile. This is not essential, but is done to avoid using any number of sizes. The use for which the box is made determines the dimensions of height, width, and length. There are no set rules. The nearer the box is to the form of a cube, the more it will hold for the amount of material on the outside. Boxes are often made of wide boards dovetailed at the corners. Except for small boxes used for toilet articles, this is not a suitable problem for school work.

WALL CABINET

Wall cases for a variety of purposes may be made similar to Fig. 207. By using art glass in the doors instead of panels, it becomes a fine plate or china case. With mirrors instead of panels, it is suitable for a toilet case.

The size may be altered by changing the dimensions of each part, either to larger or smaller; or it

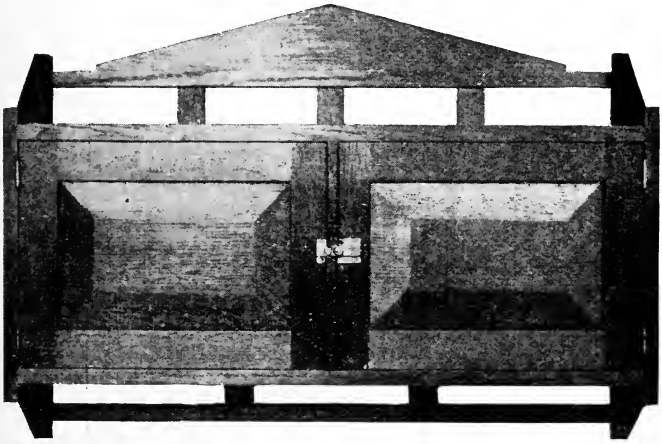


FIG. 207. *Wall cabinet*

may be made with one door instead of two, making the width but one-half that shown in Fig. 208 *a*.

In place of the square rod beneath the case, a towel roller may be used. The top may be made high enough to hold books, and the interior also may be used for books. This size will allow for two rows,

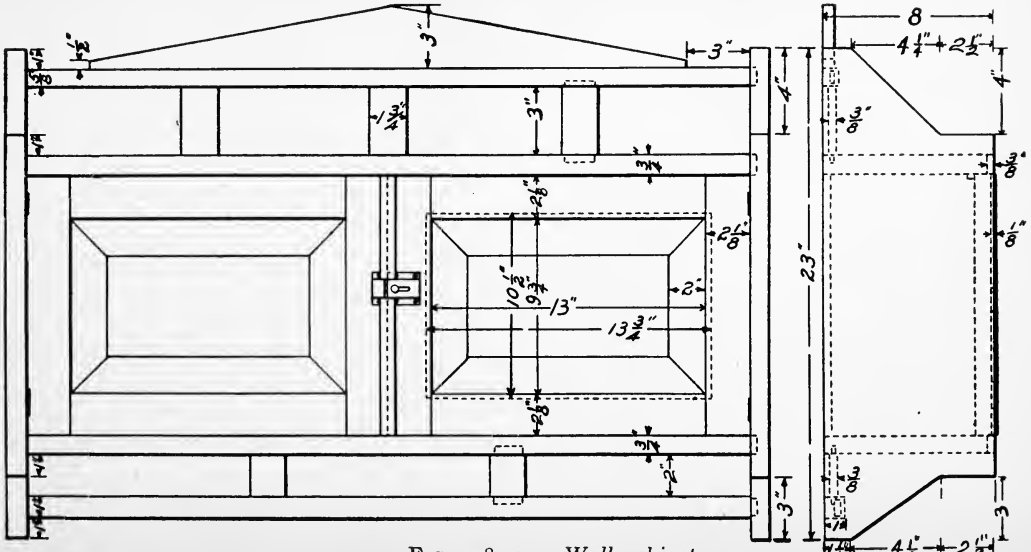


FIG. 208 (*a*). *Wall cabinet*

one on the bottom and one on a shelf. The case can be easily planned high enough for three rows of books.

Notice that there are no curved parts to perplex the maker. The ends are worked in the ordinary way for squaring and jointing. The oblique surfaces at each end are lined with a knife and the waste material is sawed off close to the line, but leaving enough to smooth with plane and chisel. A scraper may be used before sandpapering. Be sure to leave the end square across as tested from the face surface.

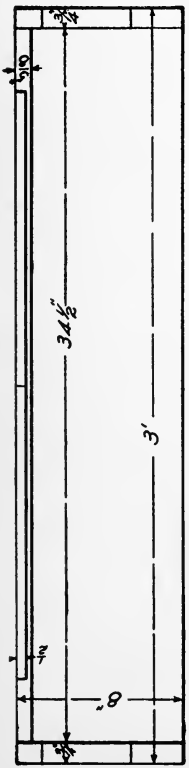


FIG. 208 (*b*). *Wall cabinet*

The rails are first glued to the shelves (Fig. 209) and then the whole is clamped together (Fig. 210). The back should be carefully fitted, and should be glued and nailed in place before the doors are hung. Cases of this type are held rigid by the backing, and hence the necessity for being careful about fitting it; also for securing it so that it will not be liable to work loose.

The making of the doors follows the general directions for making panels. Directions for hanging the doors are found under the topic head

"Hinges," Part III, page 239. In fitting doors a common mistake is to fit them too tight. There

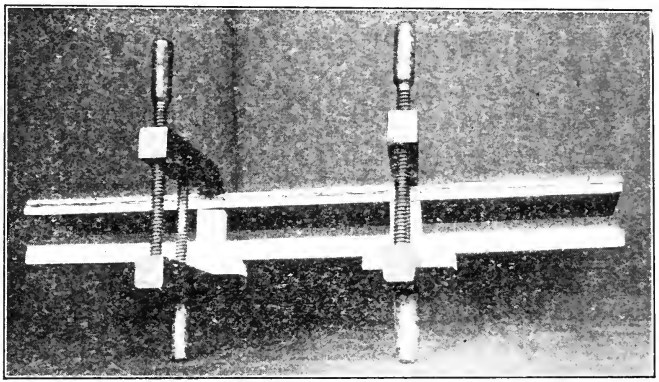


FIG. 209. *Gluing rail to shelf*

should be a small space at both top and bottom, and also between the two doors—about $\frac{1}{16}$ of an inch.

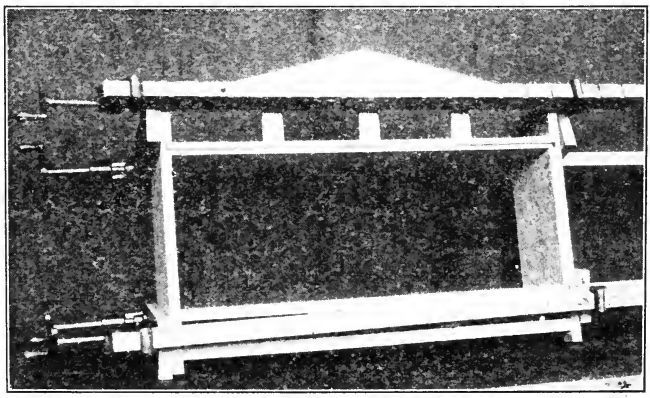


FIG. 210. *Gluing together*

LADIES' DESK

The chief feature of this desk (Fig. 211) is the framework of $\frac{7}{8}$-inch stock. This affords an opportunity to illustrate the process of uniting by doweling.

The method of doing this work is the same as that for doweling the footstool (Fig. 113); but, because the piece is larger, some difficulties will be encountered that were not met with in making the footstool.

FIG. 211. *Desk*

Probably the most important difficulty is that of getting the pieces out of wind, and of keeping them out of wind while putting them together. As dowels are to be used, the various pieces are cut to the exact length given in the drawing. The ends should be squared very carefully, so that there will be no broken edges or rounded corners to result in open joints.

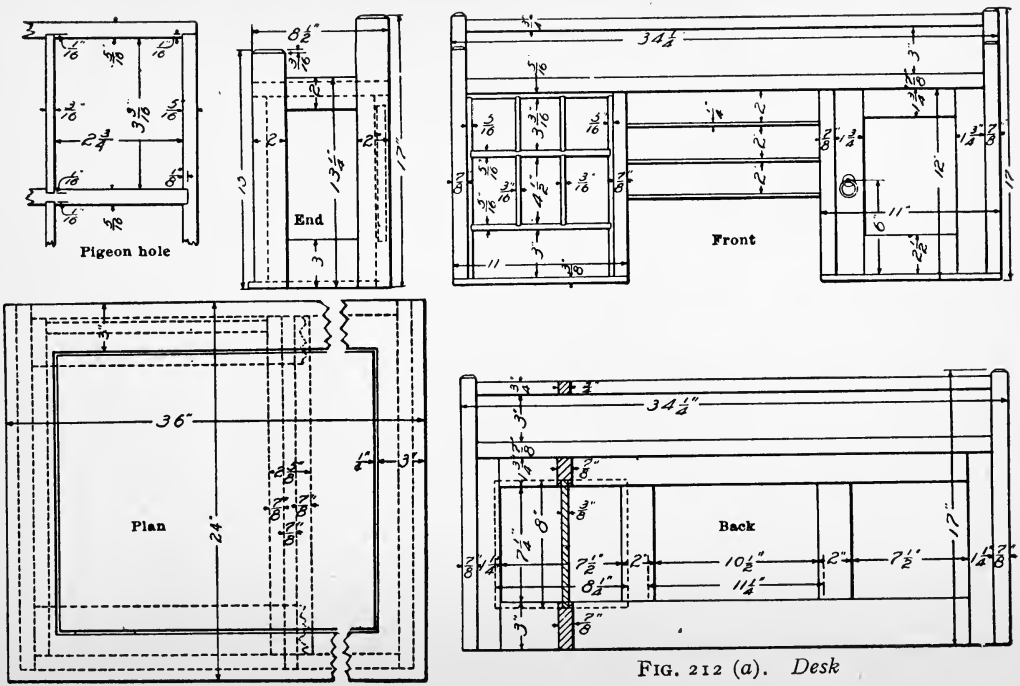


FIG. 212 (*a*). *Desk*

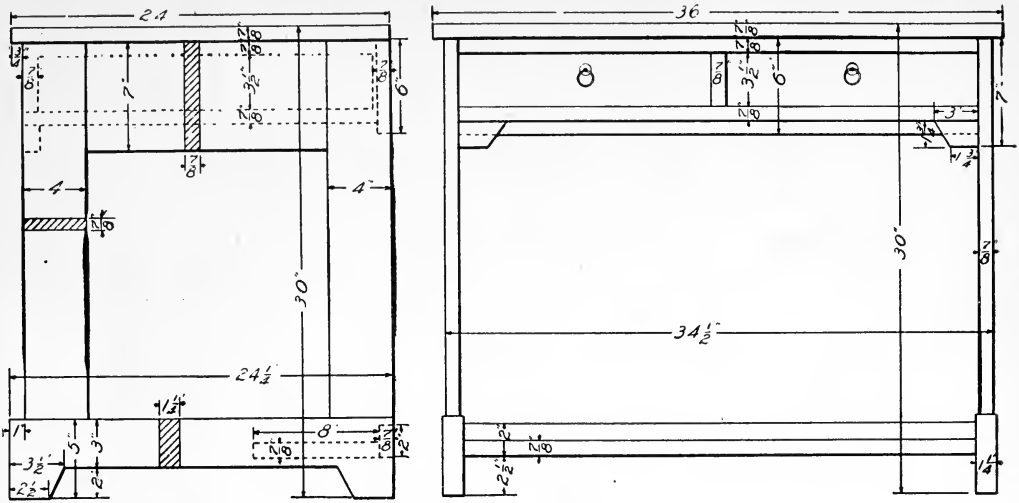


FIG. 212 (*b*). *Desk*

After studying the directions for the dowel joint in "Elementary Woodwork," and the directions for doweling the footstool (page 120), you should be able to do this doweling properly. Fig. 213 shows the arrangement of the dowels, and Fig. 66 how they are clamped. The rails and shelf are made and clamped in much the same way as were the parts of the table (Fig. 185).

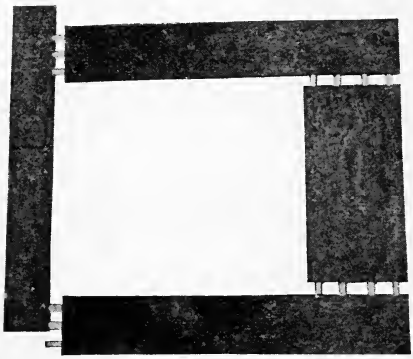


FIG. 213. *End ready for gluing*

Make the ends first, shaping them as shown in Fig. 213. The top is simply a large piece of paneling, with the panel sunk just far enough below the surface to allow for covering with cloth.

The two drawers are made the same as others. Directions for making them may be found on page 53.

The part containing the pigeon holes and book stalls is made removable, being held in place only with dowels. For this purpose two dowels are sufficient. They should be glued into the top section so that when it is removed the top of the desk will be smooth. The doors are made the same as paneling and hung as directed under the topic head "Hinges," page 260.

BOOKCASE

After a careful study of this design (Fig. 214), you should be able to design a case to suit your own special requirements. The most common modification of this design is to make the case only about half as wide and use but one door.

FIG. 214. *Bookcase*

The ends may be as shown in the drawing (Figs. 215, 216, and in Figs. 217 and 218), or they may be

plain $\frac{7}{8}$-inch paneling. In very cheap cases, the ends are simply wide boards. The back should be well made. (See topic "Backing," page 71.)

In order that the case may be taken apart for packing, the various pieces are held in place with screws. Fig. 219 shows how the blocks are fastened

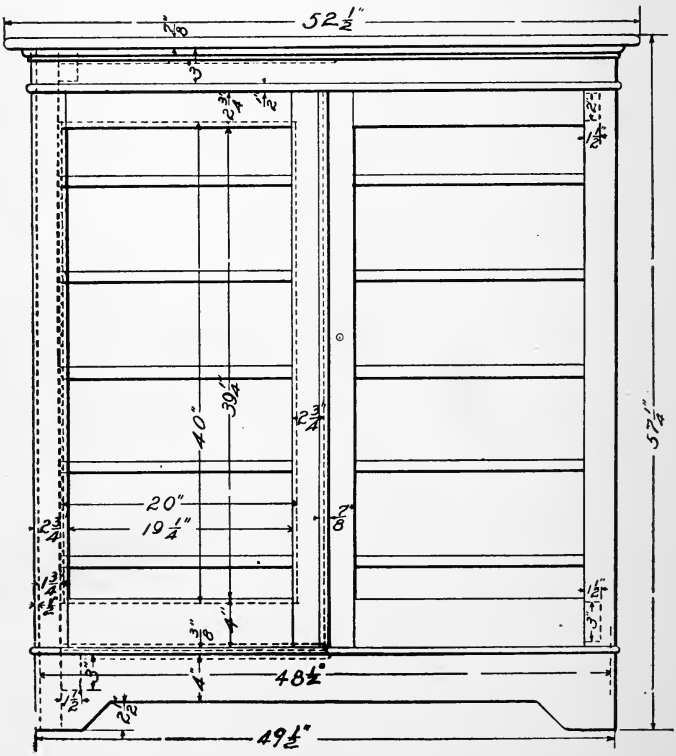


FIG. 215. *Bookcase*

to the top, and Fig. 222 how they are fastened to the bottom. Fig. 219 also shows the molding which is beneath the top. This molding covers the joint at the top of the ends and the upper edge of the lintel.

If this is done the whole may be packed in a space less than half the size of the case. This method of construction will also be convenient for pupils who wish to avoid the expense of drayage, for when the case is taken apart no piece will be too heavy to carry. However, if the knockdown feature is not wanted, the case may be secured by using glue in connection with the screws, or some of the blocks may be omitted and dowels used in their place.

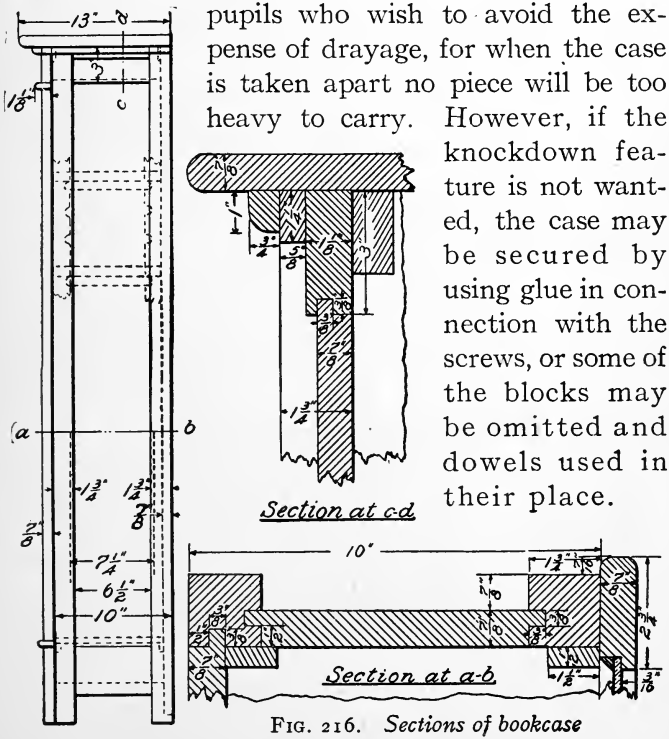


FIG. 216. *Sections of bookcase*

Fig. 220 shows the lintel board with blocks near the ends by which it is secured to the sides, the strip along part of the the upper edge by which it is secured to the top, and the strip along the lower edge against which the doors strike.

Fig. 217. *A bookcase end*

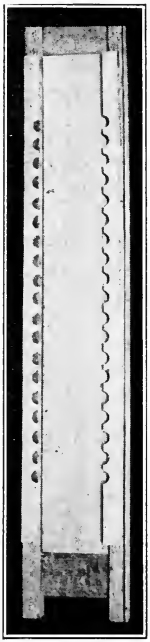


Fig. 218. *Inside of bookcase end*

Fig. 221 shows the piece which is placed below the doors. This piece requires a block near each end to secure it to the sides, and a strip at its upper edge to secure it to the bottom of the case.

Shelves. The shelves are supported on cleats. These cleats are supported at their ends in semicircular openings in the edges of strips glued to sides (Fig. 218). To make these strips, get out a piece of material wide enough for all four and square it. Draw a line in the center of one side, and lay off the spaces for the holes. Bore the holes, and then split the piece. Plane both halves, and then rip them.

Plane the last surface with a hand plane. This should result in four pieces exactly alike.

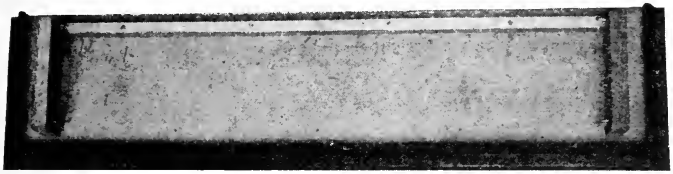


FIG. 219. *Bookcase top*

The directions for making shelves and backing will be found under these topic heads in Part I.

FIG. 220. *Lintel piece*

Doors. The doors should be carefully made. The joints in most cases should be mortises and tenons, but dowels can be used. Some may prefer lighter rails and stiles. If they are to be lighter,

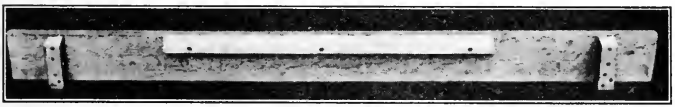


FIG. 221. *Skirting board*

they must be made with greater care and of very straight-grained lumber. If narrower stiles are used, the doors cannot be hung as shown in Fig. 215.

The directions for hanging the door and fitting

the lock and catch are found in Part III under the topic heads "Hinges," "Catches," and "Locks."

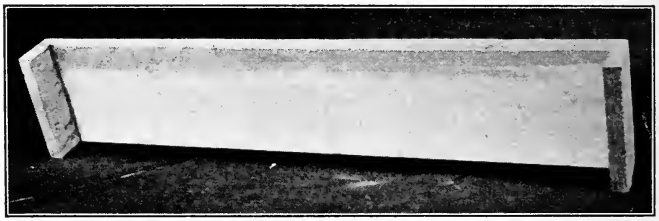


FIG. 222. *Bookcase bottom*

SCREENS

FIG. 223. *Screen*

In Fig. 223 is illustrated one style of screen; the drawing (Fig. 224) gives the sizes. These may be changed to suit any individual requirement. The turned work at the top may be replaced by paneling, and paneling may be used at the bottom. Some screens are made entirely of wooden panels of various patterns.

A very simple and plain screen is shown in Fig. 225. The bottom rails are $\frac{5}{8}$ inch thick by 8 inches wide; two top side rails are 6 inches wide, and the center rail $8\frac{1}{2}$ inches wide. The center panel is 5 feet 2 inches high.

There is little to add to the general directions in telling you how to make either of these screens. You may need to be cautioned to do your work exceptionally well on thoroughly seasoned wood, because the parts are so long that even a slight variation may throw the pieces out of square or in wind. It is not essential that the stiles and rails be of the same size, nor either of them rectangular in section.

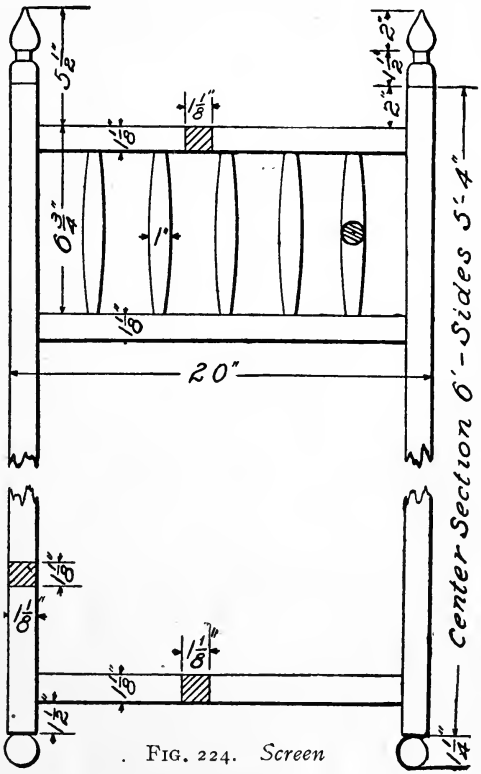


FIG. 224. *Screen*

The stiles may be plain at top and bottom or ornamented with turnings. If turnings are used, they are made separate with dowels to enter holes in the ends of the stiles.

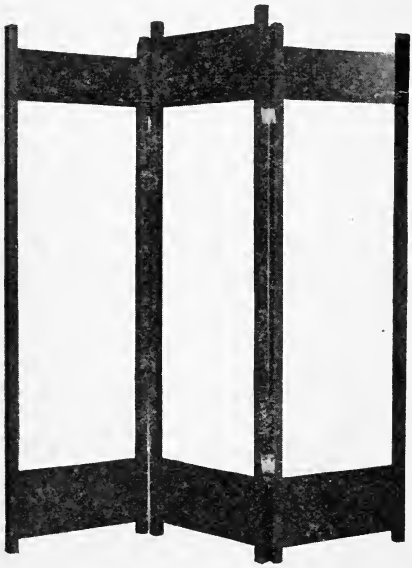


FIG. 225. *Screen*

The tapestry or other filling may be tacked to the stiles and rails, or suspended on rods crossing from stile to stile near the rails; or it may be stretched on a light framework or stretcher, and the frame nailed or screwed to the stiles and rails.

The most serious difficulty in making a screen is to secure pieces for the stiles that are straight, and that will remain so. In order to do this, the pieces should be ripped from the wide stock several weeks before they are to be used. They should be enough larger than needed to allow of straightening. After one face and edge have been straightened and squared, the pieces should be sized. Before beginning to lay out any of the mortises, carefully select

and arrange the pieces so that whatever variation remains will be eliminated in gluing.

Hinges. In setting the hinges, place the pieces in the position which they will occupy when folded. Lay the hinges in place and, by marking at each side, determine the width of the space to be cut away for them, draw lines across the pieces with a try-square and knife, and gauge the thickness of the metal at each edge so that after the wood has been removed the hinges will be flush with the surface of the stile. After inserting one screw in each rail, reverse the screen and insert the remaining screws.

FRAMES

Methods in Making. Under the heading of "Frames," we shall describe the methods usually employed in making plain frames for pictures and for similar purposes. For such articles, one of two methods of joining the pieces is usually employed. These are designated as the halved corner (Fig. 226) and the mitered corner (Fig. 232). Both of these styles of joints are described in "Elementary Woodwork," and therefore the methods of cutting the material at the joints need not be repeated. The new problem is how to use four joints in a frame so that all will be closely fitted, and the frame be of proper shape.

In such work, when the material is plain and straight, the face marks may be at the inside and best

(or face) side of the pieces. Certain shapes of molding may require the face marks to be on the inside and back, or possibly on the outside. These face surfaces should be very carefully trued. If they are at all in wind, trouble is quite sure to follow.

Rabbet. One feature of nearly all frames is the rabbet at the inside back corner which is to receive the glass or picture. This rabbet is nearly always $\frac{3}{8}$ inch each way. If the frame is very thin, the space may be less, or in the cheap and novel designs, the picture may be placed against the back, the rabbet being omitted.

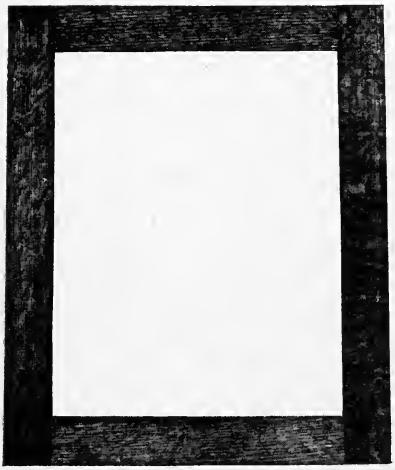


FIG. 226. *Frame*

Fig. 227 shows a frame of thin stuff, the corners halved, and no rabbet to receive glass. After the stock has been jointed and marked with the face marks, the beginner should lay all the pieces in place (Fig. 228), and mark plainly the material to be cut away. In determining this, you must decide what pieces are to appear at the front at the corners. It is usual to have the pieces, which will be vertical when the frame is in

use, full length in front, and the horizontal pieces appear to be set between them as you view the frame from the front side. This is shown in Fig. 226. Place the pieces in pairs. As there are only two of each length, it should not be necessary to clamp them. Lay off the gains at each end, and draw lines halfway across each edge. Set the gauge to near the center, and gauge each end, also gauge across the ends and on each side the length of the gain. The ends are then worked the same as a simple halved corner. See "Elementary Woodwork."

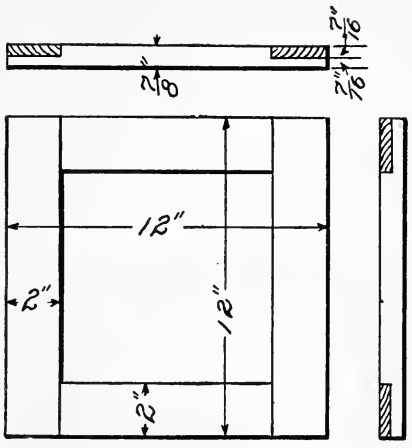


FIG. 227. *Frame*

FIG. 228. *Marking gains*

Clamping. In order to make the best joints, the pieces should be clamped in three ways: First, endwise; second,

sidewise; and third, to force the broad surfaces together. In Fig. 229 the clamps beneath hold endwise, those on top sidewise, and the four wooden handscrews and the two iron clamps hold the broad surfaces together. Care must be taken not to set the bar clamps too tight, for it is an easy matter to make them so tight that the joints will be sprung open at the outer end. The other clamping should be very carefully done, so that the pieces will not roll or tip, making the face surface uneven. The clamps beneath the frame should be level, so that the frame will not be in wind. A square should be applied at two or more of the inside corners, to find if the frame is square. This may also be determined by measuring diagonally from corner to corner. Usually, the frame can be sprung by hand until the measurements are equal. Tighten the clamps very little until the frame is square, then turn up bar clamps and hand screws.

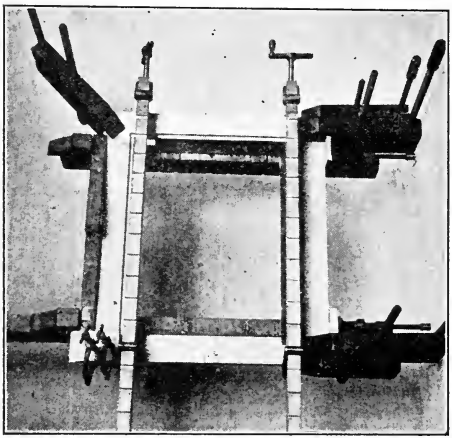


FIG. 229. *Frame in clamps*

In some cases it is easier, when a rabbet to receive glass is required, to make the joints first and then to cut the rabbet; cutting it only to the joint. This simplifies the joining and adds but little to the work. In this case, two pieces can be worked with a plow and two with gauge and chisel. In cutting out such a rabbet, the gauge lines should be made heavy and then the piece scored (Fig. 230). After scoring, the waste material is removed with a chisel.

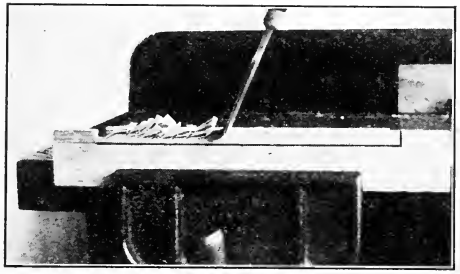


FIG. 230. *Scoring a rabbet*

Rabbeted Frame Halved. If the frame is rabbeted for picture and glass before the joints are made, the rabbet should be $\frac{3}{8}$ inch each way, as shown in the end section (Fig. 231). In calculating the size, $\frac{1}{8}$ inch should be added to the nominal width and length of the glass to allow for any roughness, or for either glass or frame being out of square.

Size. In making such frames, the most serious difficulty arises from not making proper allowance for the rabbet in laying out the joints. Referring to Fig. 231 you will see that the two parts at the corners are not cut alike. The space between the joints on two of the pieces is $\frac{1}{8}$ inch more than the corresponding

dimension of the glass; and of the other two pieces, the space between the joints is $\frac{5}{8}$ inch less than the corresponding dimension of the glass. Also, in order to simplify the joint, the pieces are not joined at the center of the thickness, but rather at $\frac{3}{8}$ inch from the back side; in other words, the joint is cut even with the rabbet. Although we speak of the joint surface being $\frac{3}{8}$ inch from the back, it should be gauged from the side having the face mark, whether this be the front or back of the frame.

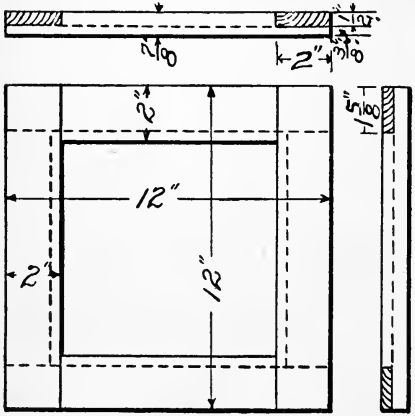


FIG. 231. *Rabbeted frame halved*

After the joint has been properly worked, test it in the clamps and, if correct, glue it as shown in Fig. 229. In addition to the glue, the corners may be bradded, or one or two screws may be used. This will help to hold the corners in case the glue should be dampened or otherwise loosened. The halved joint may be used in many places. It is usually made in one of the two ways shown. Sometimes it is combined with the miter. Such joints are stronger than a plain miter but more difficult to make.

Mitered Frames. To make a frame having four mitered corners (Fig. 232) requires careful attention to every detail. The pieces should be straight and out of wind, and, usually, the face mark on the inside. Before attempting to miter a frame, plan the length of each part, measuring at the inside corner of the rabbet. Make the frame $\frac{1}{8}$ inch larger each way than the glass. Line and work the joints, fitting each separately as described in making the miter joint in "Elementary Woodwork."

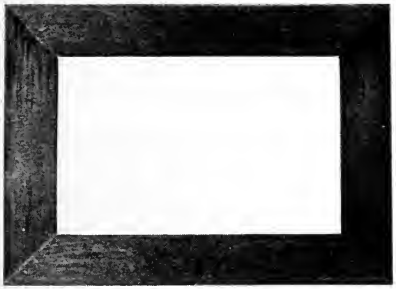


FIG. 232. *Mitered frame*

There are many ways of securing the joint, but a few methods only are of interest to the beginner. Nailing alone, or nailing and gluing, is often sufficient. Whatever method is used it is usually the better course to secure the two diagonally opposite corners first, and then unite the

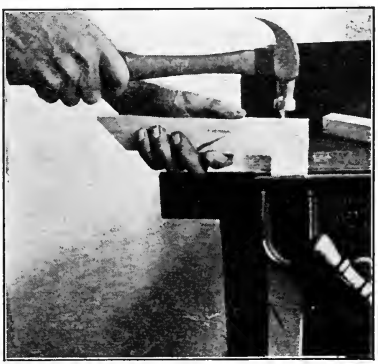


FIG. 233. *Nailing a miter*

two halves of the frame so made, unless you have clamps sufficient to hold all the corners at once. If nails are used, place one piece in the vise and the other in the position shown in Fig. 233. If glue is to be used, drive the nails in just far enough to keep the parts from slipping, then separate the joint and apply the glue. The joint will hold better if sized with glue before putting together. It should be

FIG. 234. *Mitered frame clamped*

nailed from both directions. The size of nails or brads to be used must be determined for each frame. The kind of wood has much to do with the size of nails to be used. Some woods split so easily that nails cannot be used except when holes are drilled for them. This may sometimes be done with a brad awl, but a hand drill (Fig. 265 or 266) is better.

Another way of securing mitered joints is to clamp them as shown in Fig. 234, and to nail a block at the back side. This is one of the best ways, although the blocks show at the back of the frame. Care must be taken to have the joint tight on the front side and the block and surfaces against which the block is glued very true, or else the joint will be drawn out of place. The blocks must not be so thin that they will spring and thus open the joint.

HAT RACK

This rack (Fig. 235) is a good illustration of joining by halving. In laying out the joints the same methods are followed as in laying out mortises and tenons. Read what is said under these topic heads before beginning to make this rack. Be particular to joint the pieces straight and square on both edges, also make sure they are of the same width at each end.

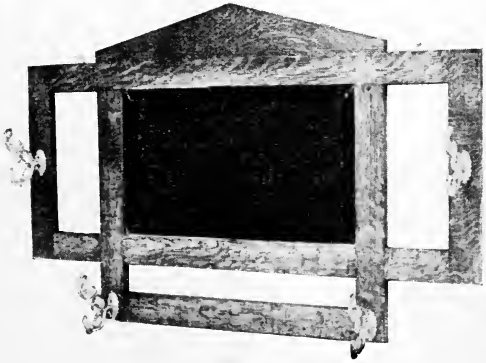


FIG. 235 *Hat rack*

Lay the pieces in position (Fig. 228) and mark

with an X the material to be cut out, being careful to have the joints as shown in the drawing (Fig. 236). Remember that if you take pains to draw all of your lines according to directions, the joints will be easily worked and the pieces go together readily. Such a combination of joints is recut or refitted with difficulty, but easily made if correctly lined at first.

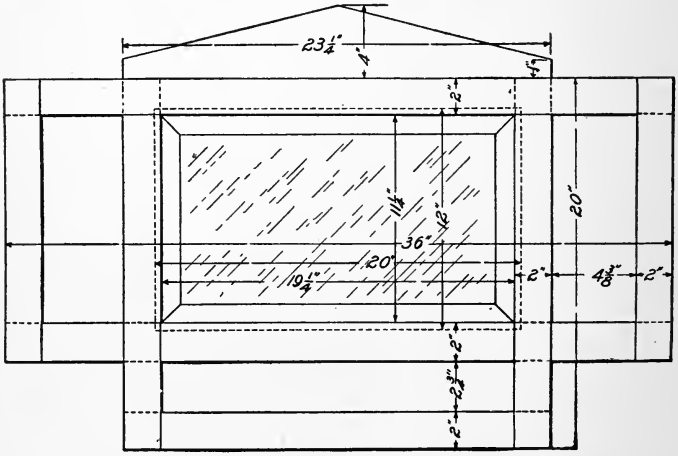


FIG. 236 *Hat rack*

Rabbet. The rabbet for the mirror may be lined with a gauge and cut out with a chisel. To do this, first score the piece, as shown in Fig. 230.

After all the gains have been cut, try the parts together and if you have a sufficient number of clamps, glue and clamp all at once; if not, it may be built up by gluing a part at a time.

The ornamental piece at the top should not be of one piece with the cross rail, but a separate piece, finished to size and glued to the rail either before or after the frame is glued together.

This rack may be modified by omitting the three outer rails, by using more hooks, and by changing the shape of the ornamental top. Another modification, and one which makes the joinery easier, is to allow each piece to project beyond the corner (Fig. 237). These pieces may be chamfered, pointed, or shaped in some other manner.

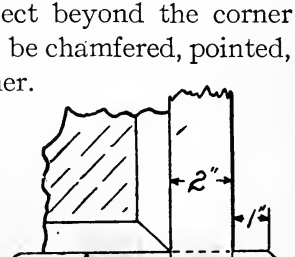


FIG. 237. *Corner joint*

There are many ways in which such frames may be ornamented. Stock of different thickness may be used, thus making more prominent either the vertical or horizontal pieces. Additional mirrors may be used in the small border spaces. The number of these openings may be increased until the framework taxes the ability of the best pupil. Panels may be used instead of mirrors in all, or a part, of these places.

The hardware may include a variety of hooks, hat-rests, etc. One part which is often neglected is the hooks or plates for securing to the wall. These should be strong and securely fastened to the frame. They are usually 16 inches from center to center.

UMBRELLA STAND

These stands may be made in a great variety of forms, from the simple rectangular frames with square corner posts to the most elaborate combinations of turned work and carving.

FIG. 238. *Umbrella stand*

Dimensions are given in Fig. 240 which may be used as a basis for the design of a stand similar to Fig. 238 or to one with square corner posts and rails.

In making the turned columns and balls, follow the directions given for turning the columns and balls of the piano bench (Figs. 191 and 198).

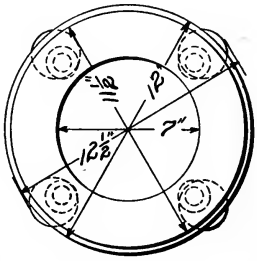
Top and Base. The top and base are sawed to near the correct diameter and fastened to a large wooden facing on the iron face plate. The under side of each should be smoothed before fastening to the facing, so that it will not require much dressing after turning.

FIG. 239. *Umbrella stand top*

By calculating where the holes for the columns are to be bored,

the screws can be so placed that the holes which they make will not be visible after the columns are in place.

Fig. 239 shows top finished ready to be removed from the facing. The base is worked in a similar manner, except that it is cut out only enough to receive the metal pan. It is necessary to exercise considerable care in boring the holes for the dowels at the ends of the columns, as a very slight variation will throw the piece out of shape. A very fine modification of the design is to use plain columns slightly curved, the top being about $\frac{1}{8}$ inch smaller than the base. There should be a small cap and also a base. Such columns may have a square cap and base with top and bottom of the stand also square or rectangular. Columns, rectangular in section but curved and tapered in length, may be used.



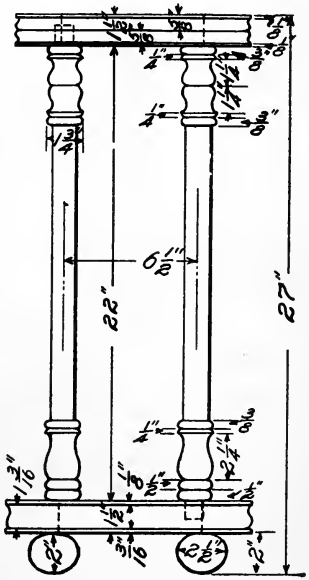


FIG. 240. *Umbrella stand*

The more common form of umbrella stands, consisting of square corner posts and rectangular rails, may be made sufficiently difficult problems for some high school pupils. Such racks have either dowel joints or mortise and tenon joints. No directions are required in addition to those for making the footstools and chairs. The spacing and width of rails may be varied to suit, and vertical slats or square spindles may be used. The usual height of umbrella stands is from 25 inches to 27 inches. The posts are usually $1\frac{1}{2}$ inches or $1\frac{3}{4}$ inches square, although they may be rectangular. Where only $\frac{7}{8}$-inch boards are procurable, the entire stand can be made by forming two ends similar to Fig. 212, and connecting these with the rails, using dowel joints. The parts should extend above the rails similar to the stiles in the chair backs. Make a complete working drawing before starting to make an umbrella rack of any style.

PART III

DESCRIPTION OF ESSENTIALS FOR CABINETWORK

TOOLS AND MATERIALS

Bit Brace Extensions. Of the many kinds of extensions for use in bit braces, the straight extension (Fig. 241) and the jointed extension (Fig. 242) are sufficient for all ordinary uses. Many first-class mechanics are able to do all their work without using either.

FIG. 241. *Bit brace extension*

The beginner in cabinetmaking may find use for them in boring holes which have been neglected until the parts are fastened together, and which will not permit the use of the bit brace without an extension. In many cases the ratchet brace will be sufficient without an extension.

The use of these appliances should be avoided by boring all the holes before the parts are in place.

FIG. 242. *Angle extension*

Bits. You are probably familiar with the auger bits and able to bore with them quite well. The twist bits and gimlet bits, though much less expensive and more simple in appearance, are even more difficult to use successfully. Because there is no spur at the end,

some pressure is necessary to cause the bit to advance, and also because the end does not cut perfectly, the bit will frequently be forced away from the proper position. This is especially true in boring such wood as oak, which has both a hard grain and a soft grain. The shanks of these bits bend easily, and the bit will often be boring at an angle when the position of the brace indicates that it is boring straight. The remedy for these difficulties is to start the bit carefully and give it plenty of time to cut.

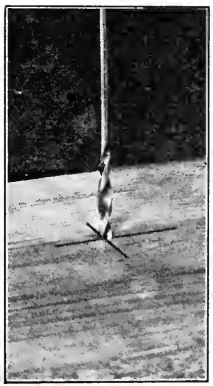


FIG. 243. *Starting gimlet bit*

Another difficulty is the drifting of the bit to one side in starting. This is caused by the end not being a perfect point and in line with the center of the bit. In order to watch the bit in starting, it is best not to depend upon a mere dot or hole, but to draw two lines across the point where the hole is to be bored, so that you can easily see whether the bit has started properly (Fig. 243).

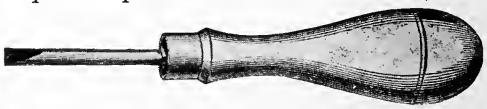


FIG. 244. *Brad awl*

Brad Awl. The brad awl (Fig. 244) is a handy tool for use in starting small nails, pins, and brads. By experimenting with it you can learn why it is

not so likely to split the wood when started with the flat end across the grain instead of being parallel with it. When you first have occasion to make small holes, get a scrap of wood and determine the proper way of using a brad awl or you may injure your work.

Casters. There is scarcely any form of caster that may be desired which may not be found on sale somewhere. Although the number of styles and sizes is very great, the variety carried by the ordinary retail dealer is not large and often very incomplete.

As a great deal depends upon the chair or table resting properly and being of a proper height, the safest way is to get the casters before completing the drawings. This also applies to most of the hardware. Some casters are very prominent and require specially shaped ends on the legs; while some of the newest styles of ball-bearing ball casters may be sunk almost entirely out of sight.

It adds greatly to the appearance of chairs (Fig. 155), and tables (Fig. 188), for the casters to be invisible; but if the casters are to be hidden, the legs should be at least an inch longer than where the ordinary visible casters are used. Be careful also to procure the proper size of casters to sustain the weight. Remember that there are casters with two wheels and some specially constructed to sustain the weight of heavy tables and bookcases. These usually have ball bearings or wheels to facilitate swinging or reversing.

Catches. Fig. 245 shows the ordinary spring catch in place. Fig. 246 shows one form of catch for the inside of cases having two doors which come together. Fig. 247 is called a flush bolt. It is a nice style and is used for the same purpose as Fig. 246.

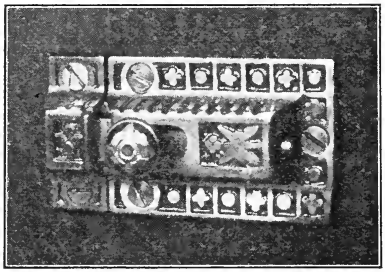


FIG. 245. *Spring catch*

Clamps. In addition to the clamps furnished by dealers, there are two styles which may be made of scrap lumber, and are quite as good for many uses as the more expensive kinds.

The first is made by fastening two pieces to a board (Fig. 248 or Fig. 71). Notice that one piece is placed at an angle, so that the side of the wedge will fit tightly against the piece which is being clamped. Sometimes, strips nailed to a rough bench and used with wedges are sufficient.

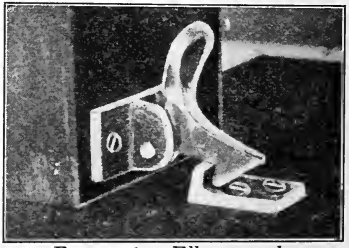


FIG. 246. *Elbow catch*

In making the clamp shown in Fig. 248 the blocks may be held in place by nails, screws, or bolts. If the nails are properly located and properly clinched, they will hold about as well as will either screws or bolts.

In locating nails for such work, the grain of both pieces should be considered, so that there will be little tendency to split. This is accomplished by not locating two nails in the same line with the grain. If the grain is quite straight in both pieces, the nails should be as shown in Fig. 248.

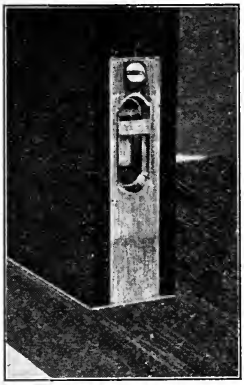


FIG. 247. *Flush bolt catch*

The most important part of the work in nailing up clamps is the bending and clinching of the nails. To drive them to place and then bend them over, is to waste a large part of their holding power. For such purpose the nail should be considerably longer than the thickness of the combined pieces. For nailing two 1-inch thick pieces together, the nails should be 3 inches long. After the point of the nail has passed through about $\frac{1}{2}$ inch, it should be bent down, and then the head should be driven tight to the surface and laid upon a flat iron (Fig. 249). A well directed blow on the bent end will turn it down and into the wood. The nail should enter so as

FIG. 248. *Board clamp*

to cross the grain, and not be driven so tightly as to crush the grains of wood. A still better way, if you have a pair of strong round-nosed pliers at hand, is to drive the nails entirely down, and then bend the end on a curve with the pliers so that when the head is laid on the iron and the hammer used on the point, the nail will reënter the wood in a curve that will draw very tight and smooth.

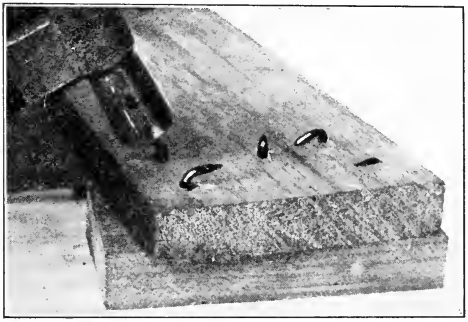


FIG. 249. *Clinching nail*

A good deal of judgment is required to know just how many nails will give the best result. There should be as many as can be used without weakening the pieces. In hard wood it is sometimes better to

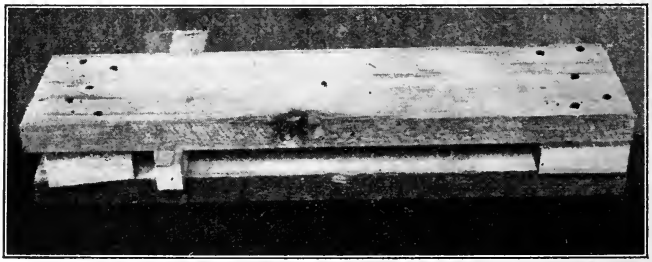


FIG. 250. *Double board clamp*

bore small holes for the nails. These holes should be small enough in each piece to require the nails to be driven with considerable force.

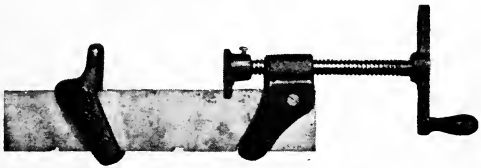


FIG. 251. *Wooden-bar clamp*

Similar to the clamps shown in Fig. 248 is the one illustrated in Fig. 250, the difference being that the latter has two sides. All the pieces to be clamped in this sort of clamp must be placed in position by being stuck in from one side, usually one at a time.

This requires time, but it is the only satisfactory way for clamping glue joints when cold glue is used, unless you have strong bar clamps at hand similar to Fig. 252.

It is also quite essential that the wedges be but slightly tapered—about 1 inch to the foot is sufficient. The clamp should be securely nailed as directed in making the one shown in Fig. 248. If there is any likelihood of glue being squeezed from the joints and sticking the work to the clamps, bits of paper should be placed between the glue joints and the sides.

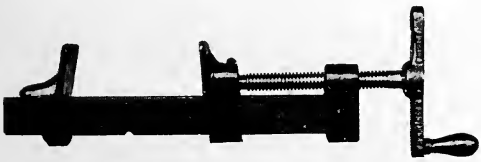


FIG. 252. *Iron-bar clamp*

Although the home-made clamps may be used with considerable success, the standard screw clamps

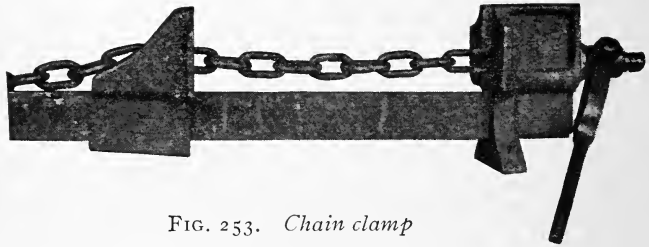


FIG. 253. *Chain clamp*

are much better and will save time. Fig. 251 shows one of a large class of wooden-bar iron-screw clamps. For many purposes these are the best kind to use because of their lightness.

In Fig. 252 we have a very strong iron-bar clamp, which may be used for small glue joints. Fig. 253 shows a chain clamp. This is probably by far the best clamp for use in gluing up table tops and similar work.

Compass Saw. Remember that the compass saw (Fig. 254) is for sawing lines made with the compasses, and for similar uses, and you will not be troubled about remembering its shape; because you will understand that if it is to saw around a circle, it must be narrow in order to follow the curve.

FIG. 254. *Compass saw*

This saw is not only made narrow, but it is made

thick on the cutting, or toothed edge, and thin on the back edge. It is also made very narrow near the point, so that it can be used near the point for sawing very small circles.

FIG. 255. *Corner iron*

It may also be used in starting a kerf for the side of a hole (Fig. 169). As soon as the kerf is long enough to receive the end of a ripsaw, the compass saw should be used instead of the ripsaw.

In sawing circles or curves, the compass saw should be moved at right angles to the surface (Fig. 97). This saw is not intended for ordinary ripping, nor should it be used in place of a handsaw. The teeth and form of blade required to make it work freely around curves cause it to cut roughly and slowly in other places.

Compass saws are made of various sizes and their blades are usually softer than the blades of handsaws. When bent, if proper care is taken, they can usually be straightened.

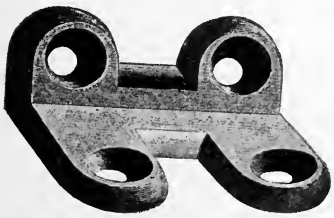


FIG. 256. *Corner iron*

Corner Irons. In Fig. 255 we have an illustration of the common corner iron for use in fastening tops and similar pieces. On page 96 will be

found directions for its use. Fig. 256 illustrates a corner iron for heavy work; such as fastening benches to the floor, and other similar purposes.

Countersinks. Of the many styles of countersinks for use in making holes for the heads of flathead screws, the double-lipped *S* pattern (Fig. 257) will make the smoothest hole. This countersink cuts nicely when carefully used, but it must be kept sharp and used with care or it will break. Fig. 258 is a stouter make and does good work; but it will not cut as well as the *S* pattern. Fig. 259 is called a rose countersink, and is suitable for hard wood, knots, and metal. If it is to be used for wood, it is best not to use it for metal because such use dulls it too much to cut wood to advantage. These countersinks, though hard enough for brass and soft iron, can usually be sharpened by careful filing.

FIG. 257. *Double-lip countersink*

FIG. 258. *Snail countersink*

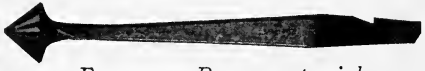


FIG. 259. *Rose countersink*

Dowel Rod. The dowel rod is usually made in dowel machines. The ordinary sizes vary by sixteenths of an inch, from $\frac{1}{4}$ inch up to $\frac{5}{8}$ inch. For special purposes, it is made both smaller and larger.

These rods may be purchased in lengths of about

36 inches, either single rods or in bundles. If much doweling is to be done, you would better use the machine-made dowels; but if only a small amount of rod is needed, you ought to make it. There are two ways in common use for making a dowel rod. The best rod is made by following the directions for making a cylinder given in "Elementary Woodwork." Another method is to plane the rod to nearly the correct size and then drive it through an iron plate (Fig. 260). This is supposed to leave the rod both smooth and of uniform size. Usually it does neither. The dowel plate may be made of steel and tempered, but it is often made of a bit of scrap iron. The holes are drilled and then reamed from the back or under side. The upper surface of the plate is nearly, or quite, flat. One plate may have holes for dowels of different sizes, or the holes may be nearly alike so that the dowel rod may be made by driving it first through the larger hole and then through each smaller size in order, thus reducing the rod little by little. This may produce a smoother rod but it requires much time.

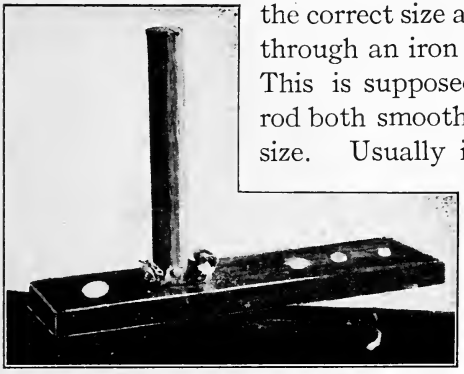


FIG. 260. *Driving dowel rod*

Drawshave. In Fig. 261 is illustrated the common form of a drawshave. Fig. 173 shows how it is held and used. This tool is ordinarily held as shown, and is used so that the blade cuts first near one handle and then near the other; making a shearing cut, the shaving curling off. This, however, is but one of many ways in which it is held, and the only way to determine the best position in which to hold and use it, is to try the various positions and thoughtfully test each.

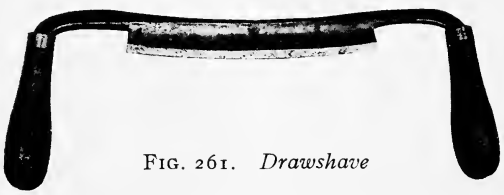


FIG. 261. *Drawshave*

Escutcheons. These are made in a great variety of forms. Some are made to be screwed or nailed to the surface (Fig. 262). The nails used for this purpose are usually short with hemispherical heads, and are called "escutcheon pins." Some escutcheons (Fig. 263) are made circular in shape so that they will fit into a hole made by boring with a common bit, and are usually held in place by glue.

FIG. 262. *Fancy escutcheon*

Extension Bits. These bits, though not often required, will sometimes save much time. In soft wood they work nicely, but in hard wood much care must be exercised or they will be broken. Keep them very sharp, and do not crowd them.

FIG. 263. *Round escutcheon*

There are several styles on the market. The one illustrated (Fig. 264) is best for most work. In setting it, use a screw-driver with a well shaped end and as wide as the screw head so that you may not injure the slot in turning the screw.

Often such a bit may be used to bore at a corner and thus avoid the working of the curve with other tools. Sometimes ornamental designs are made entirely with such bits. The bit will bore quite smooth if carefully held.

Finishing Materials. Ordinary finishing materials are not difficult to use. To use the highest grades of finish and to produce the best results is beyond the ability of those who have only a limited time for such work. It requires practice.

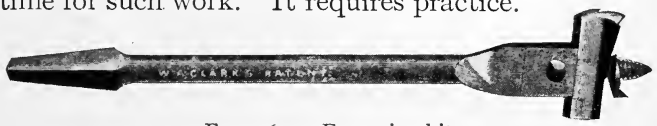


FIG. 264. *Extension bit*

The best plan undoubtedly is to use finishing materials of standard make and to attempt only

such processes as you are reasonably sure of using successfully. Materials for finishing are treated under the headings,—"Stains," "Fillers," "Pumice Stone," "Rotten Stone," "Varnish," and "Wax."

Fillers. In order to produce the finest finish on wood, it is necessary not only to make the surface smooth, but also to fill the pores of the wood so that the varnish, or other material forming the finish, will lie evenly upon the surface.

This filling has often been done by using such materials as the workman had at hand. Whiting, cornstarch, and similar materials have been much used. These, of course, must be mixed with something to make them hold to the wood, and naturally the oil and the turpentine about the paint shop would be used to mix the filler.

For many years such fillers were the sole preparations used in many shops. The discovery of new materials for this purpose has caused these old-time fillers to be discarded by most modern workmen.

There are several good reasons for the change. The newer materials are far better than the old; their proper preparation for use requires an equipment in machinery not found in small shops; while the expense of ready-to-use fillers is no greater than that of home-made fillers when all the items are considered. The results from using the commercial fillers is so much in their favor that they should be employed even if they cost much more.

Modern commercial fillers are of two kinds: paste fillers and liquid fillers. Paste fillers are used on open-grained woods, and liquid fillers usually on close-grained woods.

In selecting a filler for a piece of woodwork, get the advice and directions of the maker or a reliable dealer and then use it in exact accordance with directions. Do not think that you can judge the value of these fillers by making a few preliminary tests, for some of the characteristics of these preparations are not apparent to the novice until they have been on the wood for a long time.

Hand Drills. There are many varieties of hand drills. The best are the only ones to buy. Their use is so obvious that no directions are required. Keep the drills sharp, and use them with care. Be careful not to bore the holes for brads too large. The drill is to assist the brad in making a hole rather than to make the hole full size for the brad. Holes are seldom required in the end grain. Fig. 265 is called a geared drill, and Fig. 266 a reciprocating drill.

FIG. 265. *Geared drill*

FIG. 266. *Reciprocating drill*

Hinges. The styles of hinges which concern the beginner in cabinetwork are the plain butt hinge (Fig. 267), the surface hinge (Fig. 268), the screen hinge (Fig. 269), and the common loose pin butt hinge (Fig. 270). These various forms are made in a variety of finishes and of both iron and brass.

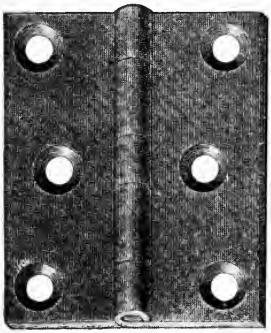


FIG. 267. *Plain butt hinge*

In setting hinges similar to Fig. 267, first locate them and draw lines with knife and try-square for the upper and lower ends, marking the length as shown in Fig. 271. Do this on either the door or jamb but not on both. Then with knife and try-square draw lines through these points out to the edge (Fig. 272 *AA*). Also draw lines down the edge to connect with the gauge line *B* when it is drawn. Next, set the gauge to the center of the space (Fig. 273) as the hinge is opened until the sides are parallel. With the gauge set for this space, draw lines on the edges of the door jamb or case side as shown in Fig. 272 *B*. This will cause the door to fit

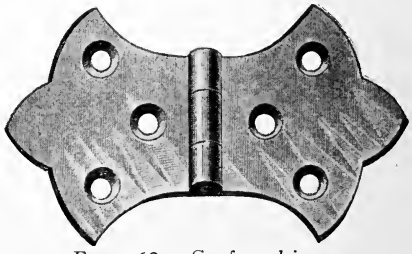


FIG. 268. *Surface hinge*

tightly. If the place for the hinge is too deep, the door will not close freely, and is said to be hinge bound.

If the space is not deep enough, there will be a space between the door stile and the frame jamb or casing. The next step is to set the gauge for the inner edge (Fig. 272 *C*). This space is determined by subtracting from the total width of the hinges the distance the hinges are to extend out from the wood. An easy way to make this calculation is to hold hinge and gauge as shown in Fig. 274.

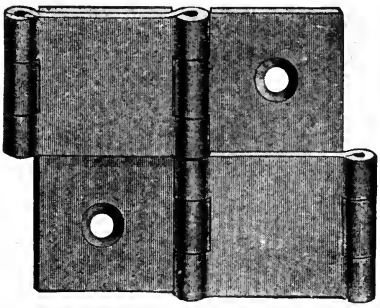


FIG. 269. *Screen hinge*

If the door and casing, or case side, are to be flush, the lines should be drawn on both the edge of the casing and the edge of the door stile, with the gauge set for the same space. If the parts are not to be flush, then the difference required is determined by the drawing of these lines. In the wall cabinet (Fig. 207), the door is set back $\frac{1}{8}$ inch from the face edge of the side of the cabinet and therefore the lines appear on

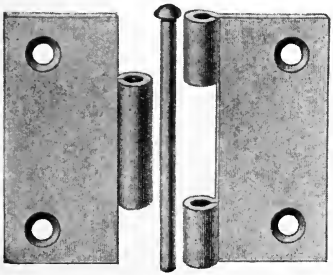


FIG. 270. *Loose-pin butt hinge*

the edges of door and side as shown in Fig. 275, the space *A* on the door stile being $\frac{1}{8}$ inch shorter than space *B* on the side of the case. After the lines are drawn, score the wood (Fig. 230), and then remove the waste, being very careful to work exactly to the lines and exactly to the same depth over the entire surface.

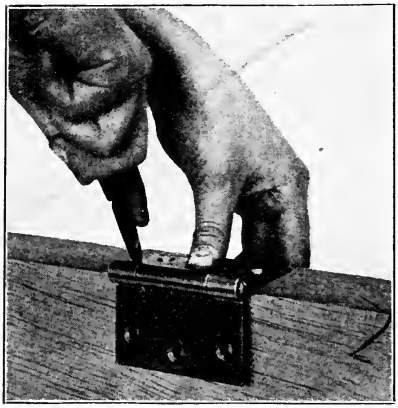


FIG. 271. *Marked length of hinge*

The chief difficulty in removing the waste material is to make the surface exactly square back from the edge or parallel with the surface of the stile. If this surface is not of the same depth at the inner edge as at the outer edge, the hinge will not hold the door properly no matter how exactly the lines have been drawn. Put the hinge in place and make holes with an awl in the

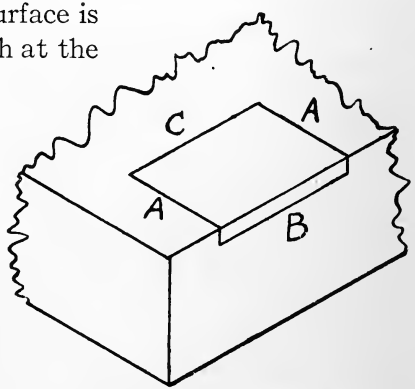


FIG. 272. *Hinge space lined*

center of each screw hole. If necessary, enlarge the holes with a bit and then insert the screws.

After both hinges are set on either the stile or casing, put the door in place, being careful to have the spaces at top and bottom exactly correct. Mark with a knife point at each end of each hinge (Fig. 276), then remove the door and draw lines with knife, try-square, and gauge for this side of the hinge, the same as shown in Fig. 272. Remove the waste as before and insert the screws, securing the door in place. Sometimes it is better to remove the hinges from the first side and fit them to the second side before attempting to fasten the door in place. This makes it easier to insert the screws. Fig. 277 shows a common butt hinge in position. With the loose pin butts

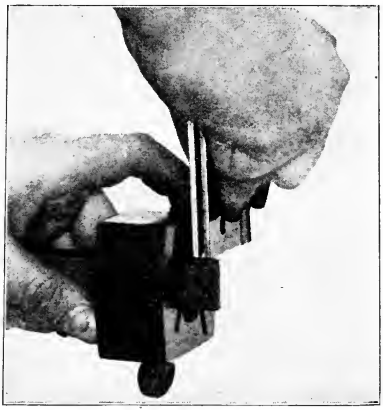


FIG. 273. *Setting gauge*

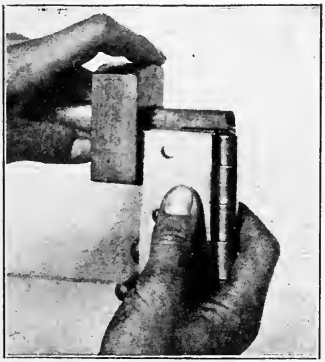


FIG. 274. *Setting gauge*

(Fig. 270) the pin may be removed and each part secured. The door may then be put in place and the pins inserted.

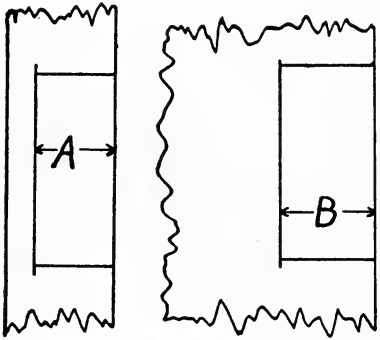


FIG. 275. *Lines on door and casing*

In such places as the top of the piano bench and the doors of the bookcase, where the hinge is entirely hidden, the hinge is first set on the edge of the box or case side, then the top or door is put in place and the location, both of the ends of the hinges and of the outer edge, is marked.

After the lines for the ends have been drawn with knife and try-square, the hinge may be placed in position, adjusting it to the scribed line, and the line for the inside edge drawn; or a mark may be made, the gauge set, and the line drawn with a gauge. The most difficult part of this

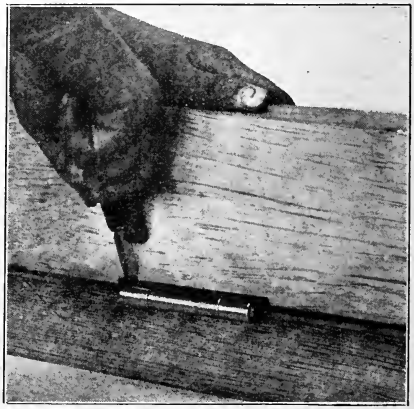


FIG. 276. *Locating hinge*

work is to cut the hole just deep enough. This is usually accomplished by a cut and try method.

The surface hinge (Fig. 268) is easily set if you are careful to locate the center of the pin exactly in line with the joint between the door and the frame or case side. Sometimes, however, there are reasons for setting the hinge a little to one side of the joint. The method of setting the hinge (Fig. 269) is given in the directions for making a screen. The loose-pin door butt (Fig. 270) is set in the same manner as Fig. 267.

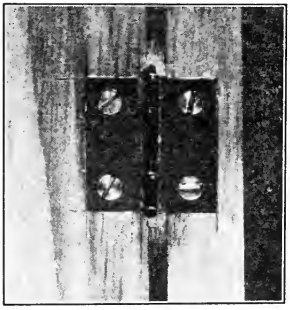


FIG. 277. *Butt hinge in position*

Locks. The variety of locks is so great that it is scarcely possible even to classify them. The common style of lock used on bookcases and similar objects is shown in Fig. 278. This is an easy lock to set, as it requires the boring of only one hole, the cutting out of a small space for the

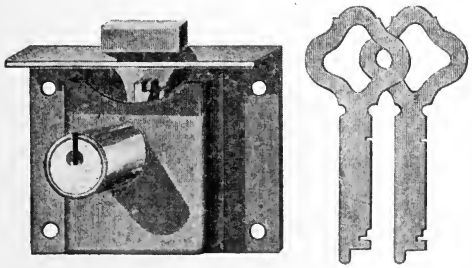


FIG. 278. *Lock*

bolt and spring, and a place on the edge of the door to bring the lock flush with the surface of the edge of the stile. The common mistake is that no allowance is made in locating the hole for letting this plate, called the selvedge, into the wood, and the hole is, therefore, just the thickness of the plate too near the edge.

Remove as little material from the side of the stile as will allow the lock to rest properly, for good wood is needed to hold the four screws. Sometimes the main plate is let in flush with the surface of the stile, but this is unusual.

In setting the plain locks used with an escutcheon like Fig. 262, holes are bored for the key and the lock then fastened in place. The escutcheon is the last part to locate, and is placed to correspond with the pin over which the key slips, or with the keyhole. If a round escutcheon (Fig. 263) is used, the hole for it must be bored before boring the small hole for the key.

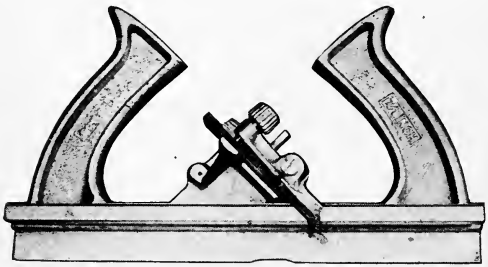


FIG. 279. *Match plane*

Match Plane. In Fig. 279 is shown a handy and simple match plane. Such a plane is useful in matching the pieces for backs. The grooving side may be

used instead of a plow for grooving the stiles and rails around a panel. Use it carefully, and keep it sharp. Your chief difficulty in using this plane is to hold it vertically. If you do not, the tongue which it makes will be too narrow and the groove too wide. As there is no side adjustment to the bit, you must be particular to grind it square across.

Mortising Gauge. The mortising gauge (Fig. 280) is sometimes used in place of the common marking gauge when laying out mortises and tenons. The single spur is adjustable by moving the head of the gauge as is done in setting the common gauge. In setting this gauge for a mortise or tenon, first turn the thumbscrew *A* at the end of the bar (Fig. 280) until the two spurs are the proper distance apart, so that you may draw the lines for both sides of the mortise at the same time. Then adjust the head of the gauge until the mortise or tenon is located at the proper distance from the face edge. The tightening of the head of the gauge also tightens the small brass sliding bar.

FIG. 280. *Mortising gauge*

In laying out such work as chair frames and the back for the large armchair (Fig. 153), in which all or a part of the pieces are not joined flush, the two

spurs are set to give the correct width of both mortises and tenons; and then, after drawing the lines on one part of the work, the head only is moved to adjust the position of the spurs for the other parts. This insures the same space between all the lines.

In the hands of the experienced mechanic the mortising gauge is of much value for this kind of work, but those not accustomed to the drawing of lines on hard wood with gauges, often will find the effort necessary to make two good lines at the same time quite beyond their strength. For this reason the single spur is apt to result in better joints on your first work, even though it is not so correct in theory.

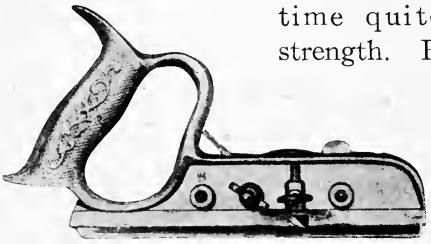


FIG. 281. *Plow*

Plow. The plow shown in Figs. 281 and 282 is sufficient for the ordinary uses of cabinetmaking. There is little need of describing its parts or of giving the usual directions for its use.

The bits should be carefully ground so that they will cut square across, as there is no means for adjusting them sidewise as there is for adjusting the plane irons. In using the plow it must be held level, for its base is too narrow to keep it square with the surface of the piece. The fence is also too narrow to do more than keep it the correct distance from the edge.

The tilting of the plow will change the position of the bit on the edge and, therefore, in testing to see if the groove is being cut at the proper place, care must be taken to hold the plow level. A common mistake in using the plow is to attempt to cut too thick a shaving. In cutting a thick shaving, the sides of the groove are likely to be roughened, and it is also much more difficult to hold the plow properly. This tool is usually supplied with several bits of different widths.

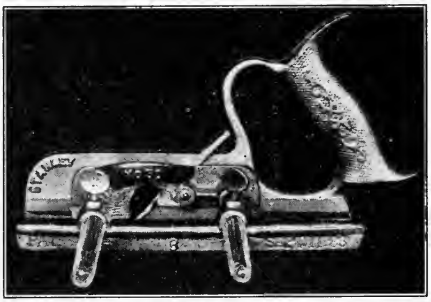


FIG. 282. *Plow*

Pumice Stone. This is a fine grit for use in grinding varnish and for similar purposes.

The successful use of grinding preparations depends almost entirely upon whether you have studied carefully the correct use of sandpaper in the elementary studies. The grinding of a varnish follows the same principles as the use of sandpaper. If, in sandpapering, you have rounded corners and dug holes, you will find your pumice stone leaving white edges and spotting your work. Do not think you can overcome the difficulty by using a very fine grade of pumice stone, for if you can use any pumice stone properly you can use the ordinary commercial grades.

The success of your efforts depends upon your knowing just what is happening beneath your hand as you rub the surface. If you have not learned this in sandpapering, you will have considerable trouble learning it now.

Pumice stone may be used with water or oil. Dealers supply a special oil, known as rubbing oil. The surface may be examined by wiping the oil and pumice stone off and holding the surface to the light. The rubbing should be continued as long as possible without cutting through to the wood. The thinner the finish, if it completely covers the surface, the better. If the varnish is very rough or contains dirt specks, use a little fine sandpaper before using pumice stone. The finer the grit, the slower it cuts. Use as coarse a grit as you can at first, and follow with the finer grades to give the proper finish. Do not mix the different grades by using the same pad for each. For a polish, finish with rotten stone.

FIG. 283. *Rabbet plane*

Rabbet Plane. The rabbet plane (Fig. 283) is used for rabbeting out corners and similar work. You will have very little use for it in your first project in cabinetmaking. You may not need it at all.

All the directions you need at first is to keep the blade sharp and at the correct angle. Be sure to have the corner sharp, so that the bit will cut a square corner. The blade should not be rounding nor have the corners taken off, as is the case with the bench planes, jack plane, and smooth plane. Do not allow the bit to cut too much at the vertical side.

Rotten Stone. Rotten stone is used in the same manner as pumice stone. For some work, the rotten stone is not required, but for fine finishing it should be used after the finer grades of pumice stone.

It is well to use the finer rubbing materials on a felt pad, although some workmen will make a fine finish by using cotton waste, old cloth, or similar material which will form a pad.

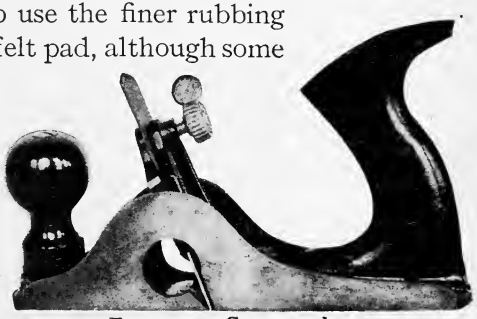


FIG. 284. *Scraper plane*

Scraper Plane. The scraper plane is a very serviceable tool. The style shown in Fig. 284 is the best for school use. For some pupils this bit is too wide because it requires too much strength, and must be made quite rounding at the sides. It should be straight near the center.

In sharpening the bits for scraper planes considerable care must be taken to make the burr

smooth, keen, and even. After it has been dressed with a file, it may be improved by rubbing on an oil-stone. The burr, when finished, should be heavier than on a hand scraper.

Be very particular not to use the plane when the burr is dull. It is only when the burr cuts a real shaving freely that it is doing good work. The bit is held so rigidly in its frame that it may do considerable harm if used with the burr in improper condition. Do not attempt to finish the work with the scraper plane. After you have done what you can to advantage with the scraper in the rigid frame, take a light hand scraper and go carefully over every spot that has not been properly finished.

FIG. 285. *Flat-head wood screw*

Screws. There are two kinds of screws usually used on furniture; the common flat-head wood screw (Fig. 285), and the round-head wood screw (Fig. 286.) The lag screw (Fig. 287) is not regularly used in cabinetmaking. Its use in furniture is tolerated rather than sanctioned. It helps to draw up poor joints and to avoid the use of mortises and tenons. No doubt we shall see less of it in the manual training shops as the work becomes better understood. The flat-head

FIG. 286. *Round-head wood screw*

screw is made in either iron, steel, or brass, as is also the round-head screw. Screws are designated both by the size of the smooth portion called the shank, and by the length in inches. They are made in sizes varying from 00 and $\frac{1}{8}$ inch long to sizes far too large for ordinary cabinetwork. Screws 4 inches long and in sizes from 18 to 24 are as large as can usually be found in the retail stores.

FIG. 287. *Lag screw*

Some dealers carry a much greater number of sizes than others. Long, slim screws, which are often very handy for the novice in woodwork, are kept by some dealers.

A flat-head screw should never be used on a finished surface where the head will show. Either a round-head screw should be used in such a place or the head should be sunk far enough below the surface to permit the hole being plugged with wood. Some manufactures save expense by gluing a button-like piece of wood over the screw head, thus saving both the trouble of counter-boring the hole and of finishing off the plug. Such makeshifts do not look well on school-made furniture. The round-head screw, although used where it will be seen, should be used sparingly (Fig. 205). In using screws of either kind, or lag screws, they will hold better if a hole is made for them and a bit of soft grease placed

in the hole. This is especially true of screws in end grain. In turning screws into the side grain of soft wood, it is not improper to drive them a little with a hammer before using the screw-driver.

Spokeshave. Of the many forms of spokeshaves, the one shown in Fig. 288 is sufficient for all ordinary cabinetwork. Unless you use it more than many first-class workmen who are constantly working wood, your chief efforts with it will be to keep it from rusting. There are so many better ways of doing nearly all the work which the novice is likely to use a spokeshave for, that it is undoubtedly better for the inexperienced worker not to have a spokeshave where he can make use of it.

FIG. 288. *Spokeshave*

To use the spokeshave for finishing the convex sides of rockers, the outside of circles a foot or more in diameter, and for rounding corners and edges, is to mark your work as that of one who is unacquainted with the best methods.

Stains. To spend time in mixing stains or in extracting colors from their natural sources, is not only a waste of time but is certain to yield more incorrect suggestions than anything else.

Information gained in limited attempts of this sort is worse than useless. Such efforts are positively injurious, and time should not be wasted in them.

It is not the proper place here to name any dealer or manufacturer of stains or varnishes, but it may be said that the later efforts of the leading manufacturers have resulted in the production of such stains and varnishes as to leave little to be desired. Stains may now be obtained which will give exceptionally fine results and yet will not streak or show laps, even when applied by the most inexperienced student on properly finished surfaces.

Varnish. There are many kinds of varnish and many methods of applying it. If you were careful in following the directions for shellacing in your elementary studies, you should have no serious difficulty in using ordinary varnish on plain surfaces. It does not dry as quickly as shellac and therefore, if too heavy a coat is applied, it will move on the surface after you have ceased stroking it with the brush. Sometimes streaks of varnish run down at the corners and joints. This is called crying. To avoid this, be very careful about rubbing all the surplus varnish away from the joints and from other parts where it is liable to gather.

The thicker the coating the better the varnish, is not true, as some inexperienced in this work suppose, but rather the opposite. The beauty of a varnished surface is in its perfect smoothness and closeness to the surface of the wood. This kind of coating not only shows the wood to better advantage, but is also more durable.

In order to produce a thin and perfectly smooth surface, the varnish is applied in several coats, and then rubbed down. This rubbing is for the purpose of making it smooth and for keeping the finish as thin as it can be and cover the surface. This is accomplished by grinding off the surface until all the raised places have been lowered to the depressions. Although the skilled workman may apply several coats before doing any rubbing, it is far better for the beginner to rub each coat carefully. In grinding off the first coats of varnish, it is usually impossible to reduce the surface to perfect smoothness, for if the grinding were continued long enough to cut down to the bottom of all of the depressions, the varnish would be entirely removed from some places, or "cut through" as it is termed. Therefore, the coating is ground only as thin as appears safe, and then another coat is applied. This, in turn, is ground to as good a surface as conditions will permit. This process of coating and grinding is continued until the required evenness of surface is produced.

Rubbing. After each coat the surface becomes more refined, and therefore finer grinding materials are used. At first a coarse sandpaper may be all that is required, but later pumice stone is used. This is followed by rotten stone, and this sometimes by even finer grinding materials. (Read topic heads "Pumice Stone," "Rotten Stone," "Fillers," and "Finishing.")

These finer materials are not required by the beginner, for the surface they are capable of giving can be obtained only by those thoroughly understanding the methods of such work.

Not only do the later coats of varnish require finer abrasive materials, but the coating material may also be of finer quality. The fillers and first-coaters often used are quite different from the varnishes, and the varnishes also may differ in grade. The extent to which this selection and refining of materials may be carried is known only to the expert. For most workmen a good filler followed by two or three coats of varnish represents their standard grade of work. Some may use different grades of varnish, but the greater number use the same varnish for each of the two or three coatings.

Preparing Surface. There is one other item that affects the varnishing which is often overlooked, and that is the preparation of the surface to receive the varnish. The wood should be polished with scraper and sandpaper before any finishing material is applied, as every mark, torn grain, or other roughness is likely to be much more visible after the surface is varnished, it should be smoothed as thoroughly as possible. Do not undertake to varnish any kind or design of work, but select for such finish only pieces that are free from corners or spaces into which the brush cannot work smoothly. This caution is especially needed if you are expecting to polish the

varnish, for the polishing cannot be done well by an inexperienced person unless the piece is quite free from corners and narrow spaces.

Problems 83, 90, 188, and 191 are especially adapted for polishing, as they are planned to be entirely finished while the parts are separated.

Wax. Following the stain, or a coat of filler to fix the stain, wax may be used. This wax may be any of the commercial compounds, or it may be the home-made mixture of beeswax and turpentine. In either case, it is rubbed on to the surface with a cloth, and then rubbed smooth and glossy. The chief difficulty in producing a fine wax finish is that the wood has not been properly smoothed nor the stain properly applied. The wax is not to take the place of scraper or sandpaper, and unless the wood surface is properly prepared the waxed surface will not be satisfactory.

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